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The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The Registered Office and Laboratories of the B.C.I.R.A. at:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Central 1885. Telegrams: CIRA
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*)

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A New Complexion

It is insufficiently realised that the character of the British metallurgical industries has changed profoundly since the war. This change has been reflected in the foundry industry. Its nature can best be summed up by the necessity of meeting a demand for lightness in engineering structures. In pre-war days trunk lines were still being constructed, navies were being created, and international trade demanded bigger and better ships. The petrol engine, the craze for speed, the development of the hire-purchase system and the increased buying capacity of the masses have altered the character of the metallurgical industries. The rail mill has given pride of place to the sheet mill; the heavy grey-iron foundries catering for shipbuilding have been slack, whilst the magnesium foundry has been growing annually to attain very respectable proportions.

The car, housing estates, the wireless set, the tin can, the vacuum cleaner, and dozens of domestic contraptions now constitute a really important percentage of the consumption of British metallurgical production. Heavy engineering has been starved, and should there be a return to pre-war activity—or even partial recovery—in this direction, then all the theories of technocracy will fall to the ground. If there is to be a parallel activity in rehabilitating agriculture by placing the British farmer in a position to compete with the overseas producer, then our labour reserve should be reduced to easily manageable proportions. The technocrats have based their theories on the permanent displacement of labour by the efficiency of the machine. With all due respect to the modern manufacturer of quantity-produced entities, be they houses or radio sets, they have not the life of pre-war goods, and after a period of heavy upkeep costs will give way to new constructions, and re-employment. The textile industries, too, have suffered because of the loss of much of their export business, but the conservation of the home markets for their unique benefit should enable them to expand by the readjustment of profit-loss, capacity-employment datum to the new conditions.

It is as well to ponder upon these mass movements of industrial activities, balancing the effect of the industrialisation of the Dominions and South American countries with the development of agriculture at home, and the consequent attenuated international trade, the race for armament construction, and the factor of quality as against quantity. The stability of countries, related in some obscure measure with the degree and length of time of civilisation of its inhabitants, is a cardinal factor. To our mind, there is but one answer to such a study, and that is, that Great Britain is better placed for attaining material progress in the race for consolidated business achievements.

Permanent-Way Castings

The Permanent Way Institution is this year celebrating its jubilee, for this body was formed in 1884, and to mark the event the London Passenger Transport Board arranged a small exhibit at the Charing Cross Underground station. This was well worth a visit on the part of those founders interested in the history of their art, and served to show that such apparently simple and commonplace castings as railway chairs have a long and varied history, and that in their present form they represent the result of a long period of evolution out of which only the fittest has survived. The actual exhibit went back as far as 1825, to the beginnings of railway development in this country, and since a piece of modern track was shown, with some modern signalling devices, took us right up to 1934.

Among the items of interest are, for example, some early cast-iron chairs bedded on stone blocks taken from some sidings of the original Stockton & Darlington railway, and some 28-lbs.-to-the-yard malleable-iron rails and chairs from this first passenger line in the world. From the Leeds & Selby railway was a cast-iron switch operated by hand, the fireman having to act as pointsman; the piece of modern track included an electrically-operated point-switching device. Another casting taken from the Stockton & Darlington line was a series of crossings made in cast iron all in one casting, and from the York & Midland railway a malleable iron T-section rail having the joint on the chairs with a jib and cotter fixing. A pot sleeper, sleeper and chair all in one casting, was shown from the York & Midland railway. Those who think the steel sleeper novel were interested in L.N.E.R. steel sleepers of 1890, and an iron sleeper with cast chairs from the L. & Y. in 1879. Some of the recent developments were also shown, together with photographs. Few people are aware that the gap between the coach and platform at some underground stations, especially Waterloo, is actually illuminated by the action of the train itself running into the station. The method of doing this was illustrated at the exhibition.

C

Book Review

Recommended Methods for Testing and Control of Foundry Moulding Sands. (Research Report No. 108). Issued by the British Cast Iron Research Association, 21, St. Paul's Square, Birmingham. Price 10s. 6d. net.

The appearance of this report is welcome, since the first edition, which was published in 1930, went rapidly out of print. This second edition is both revised and enlarged, including sections on the preparation of samples for testing, determination of moisture, methods of preparing and ramming test-pieces, determination of bond strength and permeability, expansion and contraction, refractoriness, and, finally, chemical analysis. In addition there is a useful appendix, which includes a discussion on the size and preparation of sand test-pieces, together with a number of tests made of moulding sands used for different purposes in some of the principal districts of Great Britain. Issued so recently, nearly a year after the report on "Routine Methods of Testing Green Sands," by the Sands and Refractories Sub-Committee of the Technical Committee of the I.B.F. (Proceedings, of the I.B.F., 1932-33, Vol. XXVI), one is surprised to find no specific reference to this in the bibliography; though not a little space is given to justifying a certain type of test-piece which was not found acceptable by the I.B.F. Sub-Committee for routine sand control tests. Time will show, however, whether those who have the actual experience with two types of test-pieces and methods of ramming, will agree that the form of small test-piece now recommended by the B.C.I.R.A. is desirable for *routine* tests.

On the other hand, the inclusion of Buchanan's double-compression method of ramming will be regarded by many as a considerable advance upon the method of hand ramming advocated in the previous edition. The disadvantages of A.F.A. method of ramming appears to be rather unjustly stressed, in the opinion of the reviewer, who has had experience with both methods.

Considerable improvements have been introduced into the B.C.I.R.A. method of determining permeability—notably by introducing the method of forcing a definite volume of air at constant pressure through the rammed test-piece and noting the time taken, instead of forcing coal gas through the specimen. Apart from the fact that many foundries have no gas supply, the air-reservoir method will be appreciated, because it is in line with the method adopted by the American Foundrymen's Association and the I.B.F. Sands Sub-Committee, and enables permeability to be expressed in terms similar to those used by these two bodies.

The chapter on chemical analysis quite rightly occupies a subordinate position, since it is increasingly recognised that though chemical analysis is of value, it is of much less importance than any other tests such as bond strength and permeability. Well-known orthodox methods of analysis have been described, but no reference seems to have been made to the necessity for finely grinding the sample before determining the loss on ignition, silica, etc.

Without doubt, the report is a useful compilation, and studied in conjunction with the Routine Methods of Testing Green Sands by the Sands and Refractories Sub-Committee of the I.B.F., will enable anyone interested in this important subject to obtain a balanced view of the present position of moulding-sand testing in Great Britain.

N. D. R.

MR. L. B. HUNT, of Vauxhall Motors, Limited, has received the degree of Doctor of Philosophy (London) for research in metallurgy.

New British Chemical Standard Aluminium Silicon Alloy "B"

The increasing use of aluminium alloys high in silicon and the issue of A.I.D. and B.S.A. specifications for them has justified the demand for a standard analysed sample of this type. British Chemical Standards Headquarters has for some time been supervising the preparation and analyses of a new sample which is now ready for issue.

The standard turnings have been carefully analysed as usual by a number of experienced chemists representing the different interests which include independent analysts, a Government department, manufacturers and users, including chemists in France, Czecho-Slovakia and Norway.

The elements which are at present standardised are as follow: Si, 12.74 per cent.; Fe, 0.34; Mn, 0.005; Zn, 0.020; Ti, 0.006; Cu, 0.010 per cent.

The standard figures for traces of other elements which are present may be issued and published subsequently.

To illustrate the great interest taken in this alloy by the co-operating chemists, one of the firms (Research Laboratory of the British Aluminium Company, Limited) has made no less than ninety determinations for silicon and fifty-seven determinations for iron by three independent operators.

It is believed that this is the only standard of its kind issued in Great Britain, the U.S.A. or the Continent, and it is therefore likely to be of international interest.

The standard is issued in bottles containing 500 grms., 100 grms. and 50 grms., and each bottle is provided with a certificate showing the analyses of each chemist, together with an outline of the methods used. In particular, the methods for determining silicon will be of interest, as this element when present in quantity in aluminium alloys has presented some difficulty to analysts.

The standard is issued at a price which it is estimated will eventually cover the cost and may be obtained from Messrs. Ridsdale & Company, 3, Wilson Street, Middlesbrough, or from any laboratory furnisher.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Phosphorus and Porosity

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In reply to the queries raised by your correspondent in your issue of July 5, I would state that the Committee have found that the experimental results obtained by the use of ferro-phosphorus have been amply confirmed in routine works practice where no ferro-phosphorus is employed. The low-carbon hematite used in the experiments was of the refined type.—Yours, etc.,

P. A. RUSSELL, B.Sc.,
Cast Iron Sub-Committee,
Institute of British Foundrymen.

July 16, 1934.

THE WELDING OF CAST IRON with rods of iron or steel may result in excessive hardness at the fusion point. Where subsequent machining is required, therefore, special rods must be used. Monel metal rods have been found very suitable for making sound and machinable welds in cast iron. These rods, coated with a suitable flux for the arc-welding of cast iron, are obtainable from G. D. Peters & Company, Limited, or Murex Welding Processes, Limited, and bare Monel metal wire is available for the oxy-acetylene process. A pamphlet may be obtained from Henry Wiggin & Company, Limited, Thames House, Millbank, London, S.W.1, describing the method to be followed, and free copies may be obtained on request.

Random Shots

Scientific forecasts have lost literary caste since H. G. Wells outverned Jules Verne and science itself outwellsed Wells. Still, as you know, nothing daunts "Marksman." The following passage from a speech by Sir Harry McGowan tempts him sorely.

* * *

"Cookery still remains a traditional art. It has not yet seriously been considered from the engineering point of view. The chemistry of cookery is practically untouched. At the present moment there is not much possibility of a serious attack being made on the reformation of cooking; nevertheless, I would venture to suggest to you that within the next 50 years we shall see a revolution in the ordinary household methods of handling food, which will make our grandchildren wonder at the elementary way in which their grandparents got along, and the wastefulness with which they prepared and used their food."

* * *

"Marksman" has long held revolutionary views upon this subject. Nothing that Sir Harry can say will surprise him. Cookery is undoubtedly ready for the march of progress (to coin a phrase). The Mrs. Beeton days are past.

* * *

Just as industry is being revolutionised, some say rationalised, by closer supervision and scientific control, so cookery is already coming under the eye of the eater. I recently heard of a new plan for meeting the individual taste at public banquets. The diner does not merely supervise; he actually cooks his own food. In an effort, no doubt, to remove that turgid and fishlike look which most of us wear on these occasions, an electrical firm has put on the market an electric cooker which is alleged to cook food on the plate and on the table. You simply place your chop on the plate, tastefully garland it with one or two potatoes, and perhaps a tomato, hold your electric cooker (something like a tennis racquet) over the plate, and the thing is done, or underdone. The new idea would undoubtedly lend a touch of interest to our city functions. Imagine at a Guildhall banquet the Lord Mayor turning to a distinguished guest and saying, as one cook to another: "Excuse me, Lord Blank, but my 'Mrs. Beeton's' says 'add a little salt to the fish,' and I rather think you have been adding marmalade." To which Lord Blank would reply: "Dear, dear; I believe you are right. I must have turned over two pages at once, and I am making a baked marmalade roll."

* * *

Eventually, cooking will be standardised. No longer will cakes be "as mother made 'em," but "according to British Standard Specification." Menus will be something like this:—

MENU.

British Standard Specification No. 37852, June, 1998. (8,347 calories. Vitamins: 50 per cent. A, 25 per cent. B, 12.5 per cent. C, and 12.5 per cent. D.)

Hors d'œuvres (Chemin de Fer de l'Etat, Spec. No. 85).

Potage Mulligatawny, p_H value 3.10^{-5} (Bombay & Baroda Railway, Spec. No. 236).

Homard Americain (Bureau of Standards, Spec. No. 843).

Choucroûte Garnie (DIN. 86).

Poulet (National Mark) Gran'mère (B.S.I. Spec. No. 3942/4).

Charlotte Russe (U.S.S.R. Spec. No. 79382).

Turkish Coffee (Ottoman Spec. No. 8).

Wines: Choice of B.S. Spec. Nos. 5372/87, 8291/94, 7834/96, and 12569/95.

B.M.A. specified time for digestion, 3 hr. 20 min.

MARKSMAN.

Central Research Department of the United Steel Companies, Limited

DESCRIPTION OF CENTRAL RESEARCH DEPARTMENT OF THE UNITED STEEL COMPANIES, LIMITED

The new research laboratory recently built by the United Steel Companies, Limited, at Stocksbridge, has been opened by Lord Rutherford, of Nelson. This will form a special research department, distinct from the existing laboratories of the various constituent undertakings. It will be devoted to the more important investigations and to original research.

The Central Research Department is situated at Stocksbridge, approximately 9 miles from Sheffield on a site adjoining the works of Samuel Fox & Company, Limited, and comprises a modern two-storey building, approximately 132 ft. long by 65 ft. wide overall. The roof is of reinforced concrete in vertical tiers, superimposed on an ordinary building construction, supported by means of special fender beams, additionally strengthened by reinforced ties where necessary. It is believed to be the first attempt at a construction of this nature without the unusual supports either to ground or first-floor level. The result gives excellent natural lighting of a well-diffused character, whilst providing the maximum amount of wall space.

The necessary services throughout the building, including electric current, water, gas and telephone mains, are received in a chamber under the main entrance hall where the necessary meters and distribution boards are accommodated. Each service is carried in conduit painted with its own distinctive colour, and a commodious service duct is provided between the ground floor and upper floor so that all services are readily accessible throughout the building.

Steel-making Room.—A special feature of the laboratory is the provision of two high-frequency furnaces, of 1 lb. and 18 lbs. capacity respectively. These are interchangeable and work from the same 35-k.v.a. unit controlled by a carbon electrode-mercury spark-gap operating in an atmosphere of hydrogen. The large furnace is used mainly for producing experimental ingots, the standard size being 12 in. long by 2½ in. square, tapering down to 2 in. square. This furnace, melting at 15 to 20 kw. and a frequency of 20,000 cycles, is capable of producing 18-lb. ingots from a cold charge every 45 min. The actual lining consists of a crucible of suitable material (acid or basic) backed by a thin layer of rammed zirconia with an annular liner of fused silica immediately adjacent to the coil. The small furnace has a rammed lining and is capable of melting 1 lb. of steel from cold in about 20 min. at 7 to 12 kw. and a frequency of 30,000 to 40,000 cycles. The equipment in the steel-melting room is typical of a miniature high-frequency melting shop, consisting of gas-fired furnace for preheating feeder heads, alloy stores, casting-pit and stripping plate, and the general cleanliness is that associated with high-frequency melting practice. All forging, rolling and working of experimental steels is carried out in the works under the direct supervision of the research laboratory staff.

Macroscopic Laboratory. — Ingot sections received for examination are conveyed from the steel store into the macroscopic laboratory on a foot-operated elevating truck. They are received in the machined condition and require polishing; this is carried out by means of a small portable electric sander. After sulphur-printing, the ingots are etched while in position, on a part of the laboratory floor specially built for this purpose, where a copious supply of water and the necessary acid are conducted away. Photographing of the etched ingot is conveniently carried out with two projector lamps, the light from which may be concentrated or spread over large areas. Sections are deep-etched in a fume cupboard fitted in this laboratory.

Machine Shop.—The machine shop is equipped with a milling machine, lathes, grinding machine, tool grinder, drilling machine, finishing machine and hacksaw, each machine having an independent motor drive. These machines are of the latest type, capable of turning out work of the highest precision in the minimum of time. The shop is staffed with highly-skilled men; in addition to the preparation of test-pieces of all types, it is used for the construction of special types of testing apparatus and machines.

Heat-Treatment Room.—This section is conveniently situated in close proximity to the machine shop and is provided with a runway from the steel store. Supervision of heat-treatment is reduced to a minimum by having furnaces with automatic temperature control. For temperatures up to 1,000 deg. C. two G.E.C. furnaces are provided, one of which is fitted with recording apparatus. In addition there is a gas furnace capable of developing a temperature of 1,200 deg. C. and an electric furnace, with Silit rod-heating elements, having a maximum working temperature of 1,350 deg. C. Ample provision is made for carrying out tests on small samples, and for special tests of long duration in suitable thermostatically-controlled resistance-wound furnaces, constructed in the laboratory.

By the adoption of time switches on all the larger furnaces, they can be made to attain the required temperature at a desired time, thereby overcoming the necessity of having the furnaces running all night or losing time in heating up. The duration of heating at a particular tem-

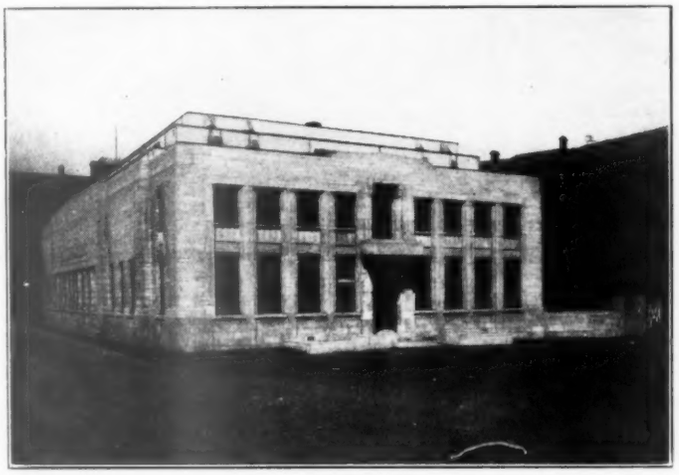

FIG. 1.—GENERAL VIEW OF RESEARCH LABORATORY.

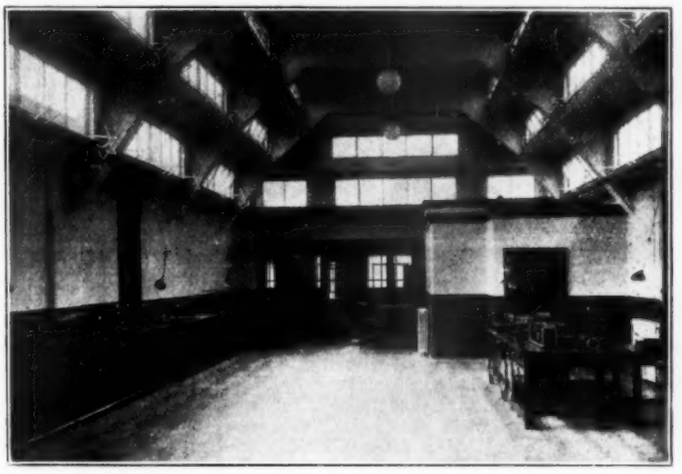

FIG. 2.—VIEW IN THE PHYSICS LABORATORY.

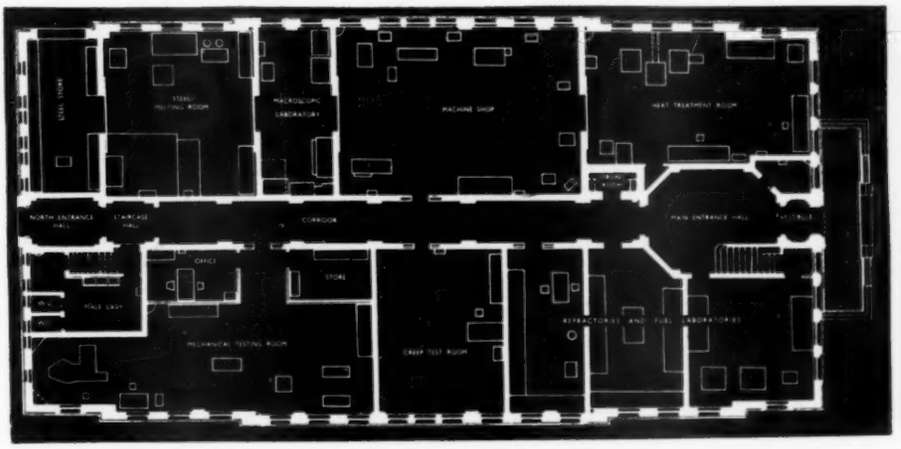

FIG. 3.—GROUND FLOOR PLAN OF THE CENTRAL RESEARCH LABORATORY.

perature is also automatically controlled. Both rare-metal and base-metal thermocouples are used in temperature measurement, and for high temperatures the disappearing-filament type of pyrometer has been adopted. A water-cooled oil bosh has been fixed in a convenient position relative to the furnaces, whilst there is also a movable water tank.

Mechanical Testing Room.—A feature of the mechanical testing room and of the remaining

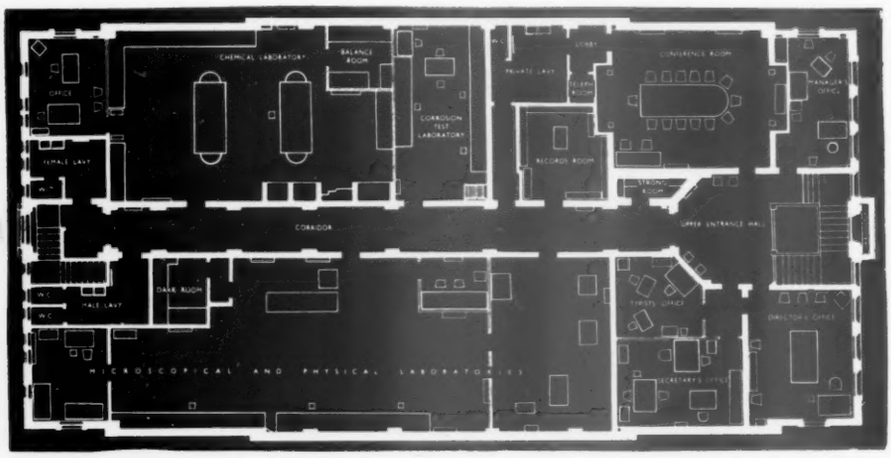

FIG. 4.—FIRST FLOOR PLAN OF THE CENTRAL RESEARCH LABORATORY.

ground-floor rooms on this side of the building is the special prismatic glass used for the windows to ensure well-diffused natural lighting. Standard equipment for the testing of mechanical properties is installed in this room, comprising:—Two Wöhler fatigue-testing machines of the rotating-bar single-point loading type, a Brinell hardness machine (Avery), a Vickers pyramid hardness-testing machine an Izod impact-testing machine and a 50-ton "Buckton" universal compound-lever-testing machine. The last machine is capable of carrying out tests in tension, deflection or compression, and is fitted with an automatic recording apparatus. The load is imposed by a 5-h.p. variable-speed motor having a speed range of from 300 to 1,200 r.p.m. acting through a change-speed gearbox so designed that the operations of starting, stopping and quick returning are all under the control of one lever, the driving motor running continuously. There are 57 speeds available, ranging from $\frac{1}{32}$ per min. to 2 per min., with adjusting speeds of from 2 to 8 per min. The load is measured by a travelling poiseweight and steelyard connected by a compound-lever system with a floating table which supports the upper grip box by three vertical stainless-steel struts, and which receives the load reaction from one end of the test-piece. Two ranges of load are given by a split poiseweight, 0 to 50 tons and 0 to 5 tons, the poiseweight being traveresd along the steelyard by a hand-wheel. Quick adjustment of the poiseweight is provided. The load is read from a scale on the steelyard and from a micrometer dial. When using the combined poiseweight, the steelyard scale reads up to 50 tons by 1-ton increments, and the micrometer dial reads up to 1 ton by hundredths. When using the small poiseweight, the steelyard scale reads up to 5 tons by increments of one-tenth of a ton, and the micrometer dial reads up to one-tenth of a ton by thousandths. Tension testing is carried out between the upper and lower straining heads, which have open sides for the ready insertion of the test-piece; the grips are operated by hand-wheels.

This machine is particularly suitable for carrying out tensile tests at elevated or depressed temperatures, since it has a definite range of speeds within which almost any desired speed of straining may be obtained, and is able to produce an autographic record. Special grips are used for these particular tests to obviate any possibility of slip between test-piece and grips which would alter the rate of straining. This is done by having a thick steel plate on each straining head, through which passes a screwed connecting rod, the position of which is fixed by a screw forming a ball-and-socket contact with the plate. For high-temperature work, a chromium-plated furnace, suspended from the upper straining head, surrounds the test-piece, and is wound with resistance wire in such a way as to give uniformity of temperature over the length of the test-piece. An attachment for testing at temperatures below normal can similarly be accommodated. The Izod impact machine has been adapted for carrying out tests at elevated temperatures by providing a heat-resisting steel block to take the place of the gripping dies. The test-piece is heated in position with the block and is well lagged with asbestos. The test-piece and block are removed from the furnace, quickly fixed in position and the test-piece broken.

Creep-Test Room.—The test employed to determine strength at elevated temperatures, known as a "creep test," usually takes the form of determining, for a selected temperature, the relationship between the applied stress and the rate of creep. Tests of this nature usually require several months to complete. Having this in mind, the selection, as a first unit of equipment, of the Barr-Bardgett creep-testing apparatus was made in order that steels might be tested in the specified period of 48 hrs., and so hasten the development of steels for special high-temperature service.

The method of test depends on the accurate measurement of the diminishing rate of creep in a stressed test-piece by means of a steel weigh-bar, so that the rate of decrease of the applied stress is proportional to the rate of creep of the specimen. The apparatus consists of a rigid rectangular frame which enables a stress to be applied to a test specimen by turning the screw at the top of the frame, the test specimen being situated inside a thermostatically-controlled furnace and connected in series with a calibrated weigh-bar and extensometer. With this arrangement, temperature is controlled to within $\pm$ 0.5 deg. C. and the variation in temperature along the test-piece is less than 2 deg. C.

In order to carry out a test, three specimens are subjected to different stresses at the same temperature, which is measured by means of a potentiometer to the nearest 0.1 deg. C. As creep takes place, the stress decreases proportionately, and at the end of 48 hrs. the decrease in stress is noted. During the course of the test temperatures are recorded on a thermograph, and it is essential that all temperatures, including that of the room, be at their exact initial value when taking final readings, otherwise a known allowance must be made for any deviation. The period of 48 hrs. has been selected as giving the desired degree of accuracy and limited test duration, and it has been adopted as standard.

The decrease in stress, which is proportional to the amount of creep, is plotted against the initial stress. The three points obtained lie ap-

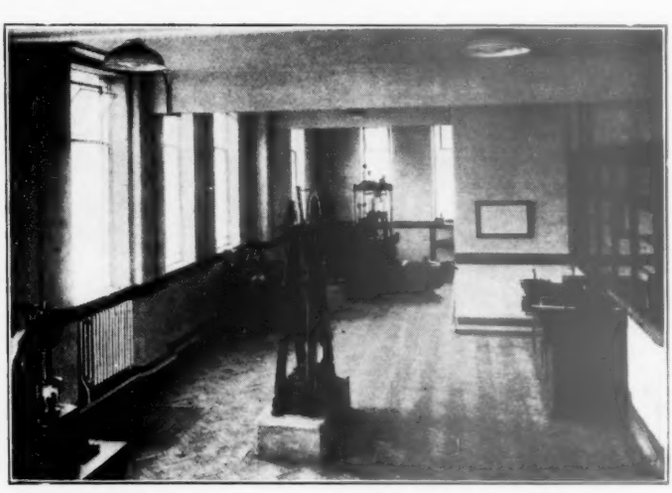

FIG. 5.—VIEW IN MECHANICAL TESTING LABORATORY.

FIG. 6.—VIEW IN LABORATORY MACHINE SHOP.

proximately on a straight line which, if produced, cuts the initial stress axis at a certain value, which represents the stress which will give no measurable decrease in stress in the periods of the test, and corresponds to a creep rate of less than 1.45 by 10^{-7} by 10 in. per in. per hr. The average rate over extended periods will generally be much less than this, usually of the order of 10^{-8} in. per in. per hr. The value of the constant-stress long-duration method of creep-testing is fully appreciated, and ample provision is made in this room for the installation of several complete units.

Chemical and Corrosion Test Laboratories

An interesting feature of the chemical and corrosion test laboratories is the walls, which consist of pale green glass with a somewhat darker shade of green beneath the service board at bench level; the fume chambers and muffle cabinet are of conventional design, being built of white glazed brick with fire-resisting and acid-resisting hoods of the asbestos type.

In addition to the usual equipment of a metallurgical-chemical research laboratory, apparatus is available for the complete examination of oils, fats and waters; gas analysis is well provided for and electrometric titration is available for the determination of PH values and the more accurate types of volumetric work. An electro-deposition apparatus is in use for non-ferrous analysis. Weighing is carried out in a separate room which is also used for the determination of carbon by combustion. The laboratories are generously equipped with balances.

Microscopical Examination.—A room is set aside for the preparation of specimens for microscopical examination, containing a motor-driven polishing machine and the usual facilities for etching. For visual examination, bench and portable microscopes are provided, whilst for photo-micrographic work there is a Reichert universal microscope.

Physics Laboratory.—The equipment of the physics department is housed in a spacious room well provided with bench accommodation. The equipment has been selected to enable the department to provide thermal and physical data for the various works' departments, for the service of customers, and for the purpose of research. Dilatometric determinations of the volume changes in steels are carried out on two alternative equipments—the Gale dilatometer and the Rohn dilatometer. Coefficients of linear expansion can also be determined. Magnetic testing equipment consists of a permeameter and an iron-loss tester with special generators for the supply of steady d.c. current and steady a.c. current of sine-wave form. The generators are housed in the basement. Electrical resistivity testing includes the measurement of electrical resistance at ordinary and elevated temperatures. The instruments include a Kelvin double bridge, and attachments for holding the test-piece and tapping off a definite length on the test, together with a galvanometer. A null method is used in determining the resistance. Two attachments, both designed in the department, are available. The first accommodates test-pieces ranging in size from thin wire to bars 1 in. section, either square or round, and from 6 in. to 24 in. in length, and is for testing at room temperature. The second comprises an oil bath, electric heaters, mechanical stirrers, with suitable devices for holding the specimen and tapping off a convenient length. This apparatus is for use up to 200 deg. C. The physics department is responsible for the calibration and maintenance of all thermo-couples and temperature indicators used in the laboratories. A portion of the physics laboratory is screened off to accommodate apparatus of a special character under investigation as to its usefulness in dealing with particular problems. The apparatus includes an X-ray tube and a magnetic crack detector, both by the Metropolitan-Vickers Electrical Company, Limited.

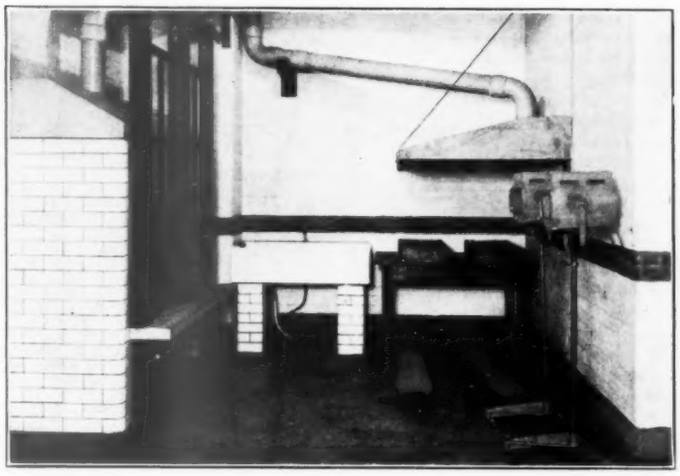

FIG. 7.—VIEW IN MACROSCOPIC LABORATORY (ETCHING SIDE).

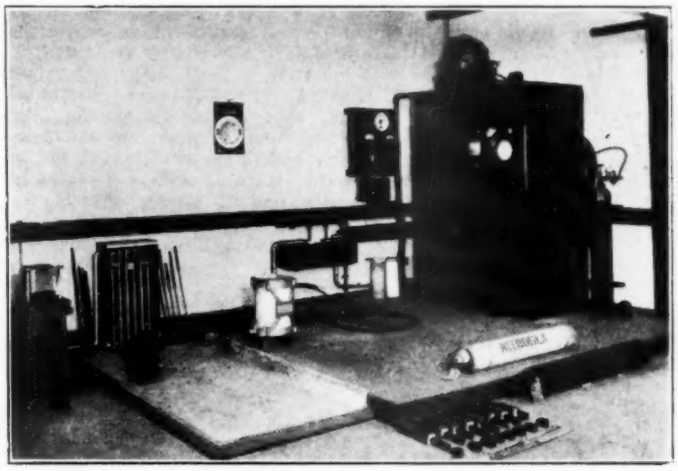

FIG. 8.—HIGH-FREQUENCY STEEL-MELTING PLANT.

Better Non-Ferrous Scrap Position

BY "ONLOOKER."

Although demand for scrap in this country is maintained at a satisfactory level and tends, if anything, to increase, the scrap position generally is easier than it was, and, although supplies are still scarce, there is not quite that famine aspect in the situation which was so very noticeable at one time. For this improvement we have to thank first of all the embargo on imports levied by Germany, which, in preventing sales of old metal to that country, has brought about an increase in the tonnage available for consumption here, not only through the medium of freer competition among the English scrap merchants, but also on account of diversion of American material to Britain.

The immediate effect of this modest increase in the tonnage available for use has been an easing of prices, more noticeable in some directions than in others. Heavy copper scrap, for example, is being rather pressed for sale, and sellers are inclined to shade prices in order to secure orders, while first-quality H.C. process material is very much more plentiful than it was, quotations being easier in consequence. There is a good deal of copper cable available just now, this product being marketed with the lead covering stripped off, so as to leave the lengths bare of insulation and only slightly contaminated by grease.

The situation with brass scrap shows also some sectional improvement, and in the case of swarf buyers are able to secure supplies at more favourable prices than for some time past. For this the restrictions imposed by Germany are partly responsible, but for some time past France has not displayed nearly so much eagerness to purchase this grade of scrap, and the inflated value obtaining on this market has declined accordingly. A more reasonable price for swarf has benefited the ingot makers, who now find it possible to procure raw material at a level which enables them to offer ingots to their customers at fairly attractive prices. The best grades of brass are scarce, and likely to remain so, as manufacturers are "eating their crusts," and very little 70/30 metal, apart from old tubes and rifle cases, gets on to the market.

Supplies of medium-quality brass scrap for foundry work are, however, more plentiful owing to an increase in imports from the U.S.A., and consumers in this country are finding it easier to secure a reasonable tonnage of old rolled brass, cut-up pipes and tubes, heavy brass, old radiators, etc. Even so, the American price idea is on occasions somewhat inflated, and merchants even although prepared to work for a minimum profit, do not find it too easy to educate the American exporting houses upon the possibilities in this market. Perhaps one of the chief troubles is that, while on a rising market the Americans do not hesitate to raise their prices at least *pro rata* with the improvement in the values of new metals, they display the utmost reluctance to fall into line when prices on the London Metal Exchange are moving downwards. Scrap metals may be something very far removed from virgin metals, but the dealer in scrap must never lose sight of the fact that his customers' selling quotations are based on L.M.E. values.

The addition to scrap supplies from within our own country are so far slight, and "hoarded" material is still being kept back, although these reserves are probably not so great as they were. Some improvement is to be noted in the rate of flow from the shipbreaking yards, but increased consumption is more than looking after this, and much more could be absorbed were it available.

TEES IMPORTS of iron and steel, which totalled 7,604 tons in April and 6,311 tons in May, fell to 3,044 tons last month, this tonnage being made up of 1,102 tons of pig-iron, 1,552 tons of semi-finished steel and 390 tons of finished steel.

Foundry Selling Practice

By Eric N. Simons

If ever there were a subject in selling that demands care and causes sales managers worry, it is the vexed one of commissions. In almost every dispute concerning commissions that crops up, it is found that both parties have at least an appearance of logic and reason on their side, and it is by no means easy to give a fair and impartial judgment. A case in point comes to mind and may serve to exemplify the matter.

A representative by good fortune happened to be working a territory in which a new industry was being rapidly developed. New works engaged in manufacturing these new products sprang up from year to year. The castings called for by this new industry were of a highly-specialised type, and design of a technical character was an essential feature in their successful marketing. Now this representative, with all his experience and general knowledge of the foundry trade, could not, unaided, have sold these castings, for the simple reason that to answer every question, he would have had to be an expert in the particular technical problems that were entailed. All he could do was to explore, ascertain where the new works were situated, and also what old firms were taking up the new business, then send word to his firm's expert. The expert then came down, closeted himself with the technical experts, talked abstruse technicalities, even sat down at the drawing board himself and designed castings for them that would give the desired results. And ultimately came away with a goodly share of whatever orders for these castings were going.

The expert, being mostly engaged on producing the castings, was paid no commissions, and had to be satisfied with getting work for his department and normal approbation. The representative's agreement entitled him, however, to a fairly liberal commission on the castings, a commission rate drawn up when orders for these particular parts were few and far between, and it was not regarded as likely that orders would be numerous.

Two View Points

As the new industry developed, competition for the castings became keener, and prices lower. The sales manager wrote to the representative suggesting a cut in commission. He argued that the representative could not fairly claim he had been solely responsible for getting the orders. Even at the reduced rate, he would be getting a handsome cheque, since business in this line was still good. But the reduction would be a helpful saving to the foundry, would help to pay for the expert's time and expenses, and would make it easier to get more orders.

To this the salesman replied that the fact the commission rate was drawn up when orders were few and far between was good luck for him, just as it was bad luck for him that other lines had fallen away to nothing. While it was true he could not get the orders alone, he, by his efforts, kept the firm on good terms with the buyers, looked after them socially, found out where new work was to be had, took the expert to the right people, and generally did all sorts of work the expert alone could not do in the limited time at his disposal. If every line that turned out good in bulk commission was to be cut, were the firm prepared to raise his commission on lines that dwindled for one reason or another?

Obviously, both sides have a certain amount of justice in their arguments. They are merely looking at the matter from different angles. The difficulty is to reconcile the two divergent points of view. The trouble in all or most of these commission arguments is that both sales manager and salesman are looking at the subject as individuals. The salesman sees his income going down, and fights to avoid it. The sales manager sees his profit margin diminishing, and fights to avert the evil. The result is a struggle in which each side wrests concessions from the other, a struggle that leaves both with a rather lower opinion of each other than they had before. That is a bad result.

Only too often, excessive haste is the cause of commission disputes. The sales manager, looking at his returns, sees that Jones is going to draw two hundred pounds in commission on certain castings alone, and it seems a lot. That two hundred pounds, he thinks, might enable him to take a penny off the price, and so undercut Y, his rival. It is too much for a man to draw on one line of castings only. We must, he thinks, get Jones to agree to halve his commission, and a hundred pounds will have been saved for the foundry. So he writes to Jones. If he had left Jones to draw his cheque this year, and waited a while, and then suggested the arrangement for next year, Jones might have been in a better frame of mind to agree. But Jones knows his figures. He has been counting on that £200. He has planned what to do with it. Any suggestion that shall give up half of it at once is like a red rag to a bull.

Again, sales managers are often jockeyed into cutting commissions by the envy of other representatives. Smith will come in and complain that Jones, the lucky devil, draws a big commission on these castings, whereas he, because this new industry is not a feature of his own territory, has a job to make ends meet. He implies that it is unfair, and the sales manager may incline to agree with him. The obvious answer, unless Smith has been unfairly treated in the way of districts, is to tell him to specialise on some other type of casting in his own area, and get all the commission he can on that. It may be lucky for Jones, but is there any record of Smith's having sacrificed commissions for Jones's sake when the former was doing well in a certain casting and Jones was not?

The sales manager and the salesman must, if commission arguments are to be settled without rancour, cease to look upon the issue as one between two individuals. They must approach it in the light of what is best for the foundry, because what is best for the foundry will, all things being equal, be best for themselves. If as the result of lowering his commission rate, Jones can definitely obtain more orders; if, in short, he can hope to make up, in increased turnover, what he loses in percentage rate; he will seldom be unreasonable. But if the sacrifice of commission does not mean any corresponding increase in his figures; if, in short, the only argument in its favour is that it gives the foundry a higher margin of profit, then he will not give way willingly, and there will be a good deal of justice in his opposition.

A Flexible Rate

On the other hand, if Jones is drawing a heavy commission on orders he does little or nothing to get; if the maintenance of his existing rate means either the loss of orders or the inability to afford the continual help of the expert, or both, then obviously he should be tactfully made to see reason, and to understand that the immediate sacrifice will ultimately prove beneficial.

Further, it is often doubtful whether sales managers realise how effective a selling instrument commission rates can be. All too often there is a tendency to assume that once a commission rate has been fixed at the lowest the salesman will accept, it must remain unchanged. Actually, commission rates should be as flexible as prices, so long as there is method in the flexibility. The cost accountant or the price fixer prefers fixed and unchanging commissions, because it enables him to calculate his prices so much the more easily. Fluctuating commission percentages mean harder work for him.

But can any foundry deny that where it markets more than one type of casting and the commission rates differ, there are some lines that do not get the attention they deserve simply because the salesmen are not able to make as much out of them in commission as they can on the other lines? Obviously, it is to the foundry's interest to press its salesmen to sell those lines which are most profitable for it to sell. (Foundries do not always know which are profitable, because many of them have the most erratic notion—owing to their primitive costing methods—of what goods are actually profitable to them, and very little idea of what are their most profitable lines.) Their best weapon to this end is the commission rate. If a profitable line is being neglected by representatives, it is nearly always because there is something wrong with the commission.

Sales managers too often think exclusively in percentages. They see that Jones gets 2½ per cent. on such and such castings. They see that the prices at which they can get orders only allow of 5 per cent. profit. Therefore, they argue, Jones must come down to 1½ per cent. It is seldom the profit that must come down to 3½ per cent. Yet the retention of Jones's enthusiasm may be worth far more in the long run than the immediate gain obtained by cutting down his commission. And the loss in turnover due to his loss of zest may mean that at the end of the year the profit has gone down far below the 3½ per cent. Conversely, the reduction in profit and therefore in selling price, allied with the maintenance of Jones's enthusiasm, may mean in the end a turnover increased so greatly that the ultimate profit is above even the original 5 per cent.

Agreed Railway Charges Applications

A number of applications for the approval of agreed charges under the provisions of Section 37 of the Road and Rail Traffic Act, 1933, has been lodged with the Railway Rates Tribunal. They include one (No. 97, 1934) by Messrs. Thos. Marshall & Son, Limited, Leeds, and the L. & N.E. and L.M. & S. Railway Companies, for an agreed charge per ton on iron or steel cisterns, cylinders, dustbins, incinerators, moulders' boxes, tanks, tubs and wringer stands.

Retained Austenite in Quenched Steels

In a Paper on the magnetic investigation of the amount of retained austenite in quenched steels, by M. MIKAMI, in the "Science Reports of Tôhoku Imperial University," the author deals with the determination of the amount of retained austenite in quenched steels by the magnetic method. The samples were made of five Swedish steels containing respectively 0.37, 0.57, 0.85, 1.08 and 1.27 per cent. of carbon. After the specimens had been quenched in vacuum, the magnetisation curve was taken by the ballistic method, from which the relation between the saturation value of magnetisation and the quenching temperature was obtained. This relation shows approximately the amount of retained austenite. The change in magnetisation of quenched specimens during heating from room temperature to 600 deg. was also determined by a magnetometer, and it was found that the increase of magnetisation below 150 deg. was due to the transformation of α- into β-martensite, and that above 150 deg. was mainly attributed to the decomposition of retained austenite, the change of magnetisation due to the decomposition of β-martensite being probably very small. On tempering quenched steel it was also found that the increase produced by the decomposition of austenite at 150-300 deg. varied in parallel with the decrease in the saturation value. After the decomposition of austenite had completed by maintaining the quenched steel at 200 deg. for 13 hrs., the decrease of magnetisation occurred when the specimen was further heated to 300 deg.; this was obviously attributed to the reversible temperature effect. The decrease of magnetisation at 300-400 deg. was due to the formation of crystal lattice from cementite molecules, and that of above 400 deg. also to the reversible effect of temperature.

Influence of Graphite on the Properties of Cast Iron

When DR. NIPPER presented this Paper* at the Manchester Conference, a very warm welcome was extended to him by the President (Mr. Roy Stubbs), and sincere thanks were expressed for having travelled from Germany to present the Paper in person. Dr. Nipper extended the greetings of German foundrymen and their good wishes for the success of the conference. He was asked to convey a reciprocal message to the German Ironfounders' Association.

DISCUSSION

MR. A. HARLEY (Past-President), who welcomed the Paper as a brilliant contribution to current knowledge of graphite formation in cast iron, and expressed gratitude to Dr. Nipper, said that one of the micrographs seemed to prove that the fine graphite flakes were less resistant to corrosion than were the larger ones. That was very significant, because in automobile work one was very largely concerned with wear, and the subject of wear in cylinder barrels was closely related to corrosion. One could make sound castings w various compositions, but if there were wear in a barrel it was a bad casting—or should be. A special research by the Automobile Association had shown that wear in cylinder barrels was almost entirely a matter of corrosion. Therefore, the industry had to find an iron which not only would give a sound casting, but which would resist corrosion. Small graphite flakes were not necessarily good in cylinder iron if they were more liable than larger flakes to oxidation and corrosion during the working of the engine; so that he emphasised the point, which was a new one, and which should claim special attention. Mr. Harley also asked if Dr. Nipper had information as to the effect of small percentages of copper in cast iron, in relation to its resistance to corrosion.

Factors Influencing Wear Resistance

DR. NIPPER replied that he had not yet carried out experiments on the influence of copper in cast iron by testing samples with and without copper from the point of view of corrosion, but had merely considered it from the point of view of the amount of graphite.

Discussing the influence of the size of graphite flakes upon resistance to wear and corrosion, he pointed out that a certain amount of graphite must be present in all cast irons in order to facilitate pouring and machining. If the total carbon were all brought to one point only there would be a very big ball of carbon, and the iron would break at that point. The other extreme was to distribute the carbon as finely as possible by having a completely undercooled material; but that also was not a good thing. Between these two extremes there must be the optimum condition. The chief consideration was that the surface area of the graphite must be very small as compared with the total quantity of graphite present, and under those circumstances the wearing properties of the material were very good. There were different kinds of wear; for instance, depending on whether the material was rubbed or rolled, the wear was different. In most cases surface oxidation caused the trouble. The best wearing material was one containing not too much graphite and not too much silicon, but having a very well-developed pearlite and short but fairly strong graphite flakes in this pearlite. One could not produce temper carbon initially, but only by annealing afterwards. If one started from the fluid state the best one could do was to produce short but fairly heavy graphite flakes, so that the surface area of the graphite was very small as compared with the total quantity present.

* FOUNDRY TRADE JOURNAL, July 5, 1934, page 7.

Importance of Melting Conditions

MR. J. G. PEARCE (Director, British Cast Iron Research Association) contributed, not merely because of his own personal friendship with Dr. Nipper, but also because the author represented one of the leading metallurgical schools on the Continent; undoubtedly the leading school on the Continent in respect of research into foundry work.

The Paper might seem to be very highly technical, but it was valuable. Founders were vitally interested in the strength and mechanical properties of cast iron, and the strength was very largely governed by the structure. At one time it was thought that the strength was governed mainly by the composition; but the composition was only one of several factors affecting this matter. In this connection he recalled a Paper presented some years ago by Dr. Norbury, in which was demonstrated very clearly the effect of melting conditions; by changing those conditions, Dr. Norbury had produced, from the same composition, irons of totally different structures, and he had produced micrographs not dissimilar from some of those shown by Dr. Nipper. The fine-graphite structures then produced were referred to by Dr. Norbury as supercooled-graphite structures, being the result of a supercooling action in the melt itself. Invariably there was a temperature (or range of temperature) over which a melt normally solidified, and it was well known that, if the conditions permitted, a melt would fall below that temperature or that range before it solidified, the extent of the drop being the extent of what was called "supercooling." The structure altered with the extent of the supercooling, so that the mechanical properties and the strength altered correspondingly, and that was why the conditions described by Dr. Nipper concerned the foundry so much.

Factors Governing Supercooling

The law due to Tammann, and referred to at the beginning of the Paper, was that the number of centres of crystallisation which formed in unit volume in unit time measured the tendency to spontaneous crystallisation, and it was called the "nuclei number," represented by the letters "KZ," from the German "kernzahl." The linear crystallisation velocity was a measure of the speed of formation of these nuclei, and it was known in German as "KG"—"kristallisation geschwindigkeit." It was on the magnitude of these two and their ratio to each other that the extent of supercooling depended. An ordinary iron which did not need to be melted to a very high temperature before it was poured—an ingot-mould iron, for example, going into a thick section did not need to be melted to very high temperature—supercooled very little; but if an iron had to be superheated, then the tendency to supercooling, *i.e.*, for the solidification temperature to fall below the normal solidifying temperature, increased, because superheating tended to rid the melt of inclusions of graphite and particles of slaggy matter which in the ordinary way would promote crystallisation. If this supercooling action were pushed to its limit, and if the metal were quiet and free from ebullition (particularly obtained under the condition of Dr. Nipper's vacuum melts), one obtained the fine sooty structure which had been called supercooled graphite.

Utility of Supercooled Graphite

It had been shown, from the point of view of corrosion and wear, that this structure was not very desirable. It was curious that it should be bad to have either an extremely coarse graphite or an extremely fine graphite. That fine graphite was useful for some purposes, but not for most of the purposes for which cast iron was used, and it was to overcome the tendency towards supercooled graphite that the idea of inoculation was developed. It was illustrated in such irons as Nitensyl, which was nickel inoculated, and Meehanite, which was calcium-silicide inoculated, giving tensile strengths from 25 to 30 tons per sq. in.

The Inoculation Process

The essential feature was the inoculation of the white or mottled iron while still molten, and inoculation, which the Germans called "after-siliconisation," was of great theoretical interest. In this country there had been a tendency to regard after-siliconisation, or inoculation, as destroying the effects of supercooling; in other words, we had regarded superheating as promoting supercooling, which tended to produce this undesirably fine graphite, and inoculation was a commercial and practicable remedy against its effects. On the other hand, the Germans regarded after-siliconisation, or inoculation, as promoting supercooling. It was quite possible that both the Germans and ourselves were right, *i.e.*, that in the irons with which we had been working the inoculation destroyed the supercooling effect, whereas in the case of the irons with which they were working, in the conditions in which he was working, and with his plant and resources, the reverse was the case. Possibly we were converging on the truth, and should be able later completely to explain this extremely complicated problem. In this country we had stated all along that the inoculation theory did not quite explain everything that happened in these irons. Fundamental work of this very important kind, however remote it might appear to be from everyday practice, would result in a fuller and truer understanding of an extremely complex and very remarkable material, and a debt of gratitude was due to Dr. Nipper, not only for having prepared the Paper, but also for having come to this country to present it in person.

The Nature of "Kish"

DR. A. B. EVEREST, after an expression of appreciation of the Paper, said there were one or two points which he found a little puzzling, and in connection with which he would like further information. In the first place, referring to the coarse-graphite flakes which Dr. Nipper had called "Kish," he gathered that these were flakes of hyper-eutectic graphite of a peculiarly-coarse form, and which must therefore have formed in the iron prior to solidification. As shown in the photomicrographs, these flakes were all straight and well developed, and Dr. Everest asked, therefore, why the graphite in ordinary cast iron, some of which was generally considered to be hyper-eutectic, was always curly and distorted and showed no evidence of a crystalline form such as indicated by the flakes shown by Dr. Nipper, even after they had been broken up.

Dealing further with the form of the graphite flakes, Dr. Everest expressed particular interest in the photographs taken by polarised light. He had understood that the ordinary graphite flakes in cast iron, although ultimately crystalline, were of such fine structure that they could be considered as amorphous. He recalled the experiments carried out some time ago by Moissan in which, by forcing crystallisation to take place under great pressure, the carbon separated as small diamonds, and he gathered that these diamonds were of a different atomic structure from ordinary graphite. One would expect a diamond to respond to polarised light and to show crystallographic effects such as illustrated in the Paper. One would not expect, however, that the ordinary graphite flakes in iron would show this effect, and he would therefore like to ask Dr. Nipper whether the "Kish" graphite shown could be considered as structurally similar to the ordinary graphite flakes since, if so, then there was definite evidence here of the graphite

in cast iron being more definitely crystalline than is normally supposed.

Commenting upon the white bands around the graphite flakes, shown particularly in Fig. 2, Dr. Everest said that usually, when examining ordinary commercial iron under the microscope, one found bands of ferrite and not pearlite around the graphite flakes. One could see, however, in the particular instance shown in Fig. 2, that the pearlite had been formed there in preference to ferrite; but a point which Dr. Nipper had not referred to, to any great extent, was the fact that, by supercooling, one very often obtained ferritic structures, rather than pearlitic. In some experimental work Dr. Everest had found that, with an iron which would give an all-pearlitic structure in a ½-in. section, one obtained, in a ⅛-in. section, nests of graphite-ferrite structures, and in some centrifugal castings and other chill castings, one obtained the same structure where normally one would expect to get the more ordinary chilled structure. Prof. Hanson had suggested the theory that ferrite started life as Delta iron in the top left-hand corner of the iron-carbon diagram. Dr. Everest mentioned that Dr. Nipper had not apparently referred to this effect on supercooling, and he asked whether this phenomenon had come under Dr. Nipper's experience and, if so, what were the conditions and in what way they had differed from those involved in the present experiments. In this connection he referred to some experiments he had carried out with iron developed by Schutz, in which a hyper-eutectic composition was cast into a chill mould. By casting what would normally be a very soft iron in this manner, one could get a very dense iron showing the ferrite-graphite structure such as that in Fig. 6.

Structural Strains and Strength

He had been looking for a high-strength result, hoping to get an iron of something like 25 tons, but he had found that the strength was only about 13 or 14 tons, which was was disappointing. It had been stated both by Mr. Pearce and Dr. Nipper that these ferrite-graphite structures were not desirable, that they had no good corrosion resistance, that they were weak, and so on; Dr. Everest asked whether the reason was that the structure was atomically strained. He believed his own results had shown that one obtained a hardness of about 200 Brinell with that structure, whereas, judging from the constitution, the figure should be much less. Similarly, if the structure had been somewhat akin to malleable iron and there was fine graphite, one would expect much higher strengths. Therefore, he suggested that the change was due to the strain in the structure resulting from supercooling, and he asked if experiments had been made on the effect of annealing in order to find out whether, by removing the strain, one obtained better properties in the iron.

MR. J. S. G. PRIMROSE, referring to the importance of the examination of structures by polarised light, which was comparatively new in this country, said he had had to use that method in distinguishing between basic and acid steels; and he emphasised that one was not using the usual form, transmitted polarised light, but reflected polarised light, which was very different; and yet it had been capable of giving indications of strain in a material. When the material was unstrained one obtained a uniformly-reflected polarised-light image, but when the material was strained it gave an irregularly-shaded image, which was very important as showing that the graphite in the kish was crystalline. He had had the idea that the very fine nodular graphite which was called "sooty" graphite, as it resembled soot or dust in size, would be non-crystalline, but, of course, the polarised light would be able to reveal the truth. He gathered that undercooling really meant the same as supercooling, and he asked whether the graphite which came out under those conditions was truly crystalline. The point was that Dr. Nipper had been able to secure a very fine precipitation by means of melting in vacuum. This "sooty" graphite could be brought about by other means; for instance, the presence of titanium in the pig-iron had occasionally given irons in the pig form which were completely malleable. One did not associate that with ordinary primary or secondary graphite, and usually when one obtained a malleable pig and examined it one found the "sooty" graphite He asked if Dr. Nipper could confirm that all forms of graphite—the primary (kish), the secondary (either straight or curly graphite flakes) or the tertiary form (supercooled)—were crystalline.

DR. A. L. NORBURY (British Cast Iron Research Association), who welcomed the photomicrographs in the Paper as being among the most instructive and interesting ever published in connection with grey cast iron, discussed some work which had been carried out by the Cast Iron Research Association in Birmingham during the past 18 months. The endeavour was to find out what caused the difference, not revealed by chemical analysis, between two pig-irons from two different furnaces. This fact had long been recognised by foundrymen—and incidentally they were not always believed. Makers of chilled rolls had insisted that iron from hot-blast as against cold-blast furnaces gave different chills and different quality to the rolls, even though the chemical analysis was apparently identical. Similarly, Mr. F. J. Cook, in a Paper presented to the Institute several years ago, had shown that two pigs from different furnaces gave considerably different strengths in engineering castings, although the analyses were again apparently identical. It had now been accepted that such differences exist, and the work by Dr. Nipper and Prof. Piwowarsky at Aachen, together with that of other investigators elsewhere, had shown that the superheating of the melt could produce such differences and could produce the very fine graphite flakes shown in Dr. Nipper's Paper. The work at Birmingham, however, had shown that the same fine graphite flakes could be produced in other ways without superheating. The investigators produced at will these very fine graphite flakes on quite heavy sections without superheating or chilling, and could also change the structure back into very coarse graphite flakes without altering the ordinary chemical analysis. They now knew the reasons for the difference between irons of the same ordinary chemical analysis. Dr. Norbury regretted that he could not give a detailed account of the results yet, but he hoped that that might be possible in the near future.

Dr. Nipper's Paper contained mostly facts, and it was difficult to find anything in it with which one could disagree; but he took the opportunity to express his great appreciation of it.

Process and Structure

MR. A. CAMPION, who recalled that Dr. Nipper had attended the Institute's Conference in Sheffield in 1927 with Prof. Piwowarsky, and commented upon the pleasure of seeing him again, said the Paper was of extreme interest, and he was not sure that it was quite so purely scientific as some speakers were apt to think; it had certain practical applications. Some references he had made on the previous day to viewing cast iron from a different angle under different melting conditions were borne out by Dr. Nipper's Paper. The effect which had been referred to as supercooling or undercooling was not quite correctly called supercooling or even undercooling. In the course of his practical experience with rotary furnaces it had led to some very curious results; and he believed he had seen there a confirmation of what Mr. Pearce had said about siliconisation, that it was acting in both ways, and that sometimes the sooty kind of graphite produced undesirable results, whereas in other cases this particularly fine graphite gave remarkably good results from the point of view of strength.

AUTHOR'S REPLY

DR. NIPPER replied to the discussion. After expressing his appreciation of the manner in which his Paper had been received, he dealt with the question as to why the graphite in pig-iron or in grey cast iron was not crystallised very well. The kish was produced crystallised in the fluid material, so that the kish graphite would have considerable crystal size; but the graphite that was produced in the more or less liquid state in the small solidifying temperature range had to find a place between the austenite crystals and acquired the shapes of those spaces.

DR. EVEREST said some of the graphite which formed in ordinary cast iron was very often hypo-eutectic, as was the kish graphite, and he was asking why the former did not come out in the straight form, because it formed when the material was solidified or was partly molten. He might be wrong as to the way in which the graphite separated.

Factors Influencing Crystal Shapes

DR. NIPPER said he believed the shape of the graphite crystals depended on the time in which it was produced, the time in which the metal remained fluid. He had not carried out experimental work to discover whether or not the very fine graphite was really crystalline, though in his own mind he felt sure that it was. In the case of coke, one found the same thing. Prof. Ramdohr, at Aachen, had carried out experiments to find the difference in cokes of different reactivity, and he had found that it was just a question of the size of the graphite crystals in them. One found very small and very large graphite crystals in coke, depending on the temperature and the time of coking, and that might be responsible, in the first place, for the different reactivities of the cokes. He felt certain that there would be a similar experience in connection with iron; that the kish and the very sooty graphite were both crystalline. The expression "sooty" was a very good one; in Germany the expression "Russartig" was used, and it meant resembling soot. When the material was broken the fracture was absolutely black. The experimental work would have to be continued, though the polishing and examination of the very small graphite was not very easy. The temper carbon was built up somewhat differently. There was a point in the middle where the first temper carbon came out, and the other temper carbon was brought there from the side. The structure of the graphite parts was perpendicular to the radius of the temper carbon ball, and one had to determine whether the graphite was formed when in the fluid state or when in the solid state.

Conditions Appertaining to "Sooty" Graphite

In most cases, if there were a very sooty graphite, the matrix was ferritic, and he believed the reason was that there were large nuclei for the break up of the pearlite, and the carbon could very easily get to the graphite, which, by reason of its small size, exposed greater surface area. He had not carried out much experimental work on this matter, but he believed much depended on the amount of silicon present, and on the rate of cooling. At first he was astonished, but he had found that the whole matrix of most of his samples was definitely pearlitic.

With regard to the qualities of the material, he believed an explanation had been given that the primary dendrites grew first and continued growing when the remaining solution was already eutectic; then the material became hypo-eutectic and was brought to a small network, and afterwards the whole material had the quality of the spaces between the austenitic dendrites, where the material was in reality hypo-eutectic and the quality was very poor. So that one had not the whole of the material of the quality which one would expect according to the composition, but

(*Concluded on page* 52.)

Report of Cast-Iron Sub-Committee

APPRECIATIVE DISCUSSION AT MANCHESTER CONFERENCE

MR. A. CAMPION, after an expression of commendation of the report*, said it dealt with a large number of subjects, though some were not dealt with completely; it was all to the good, however, that the Committee should publish information from time to time in order to stimulate interest, and should submit its work to discussion with a view to obtaining tips and suggestions for further work. Prof. Campion's object in speaking was not to criticise the report but to make a few suggestions to the Committee as to directions in which it might amplify its present findings and perhaps in other cases review them.

He supported heartily the suggestion, with regard to tests, that the British Standard Specifications should be adopted in all cases as far as possible. Reference was made in the report to the difficulties experienced with the larger size of bars; but, as one who had carried out many hundreds of tests on such bars and had done some of the original Test-Bar Committee work, he had not experienced difficulties due to the knife edges digging into the bars, and he suggested that it was simply a question of the radius of the supports and of the presser foot. Neither had he experienced the difficulty of bars rolling out of position when placed on the supports.

Phosphorus in Light Castings

The main portion of the report dealt with the question of phosphorus in iron, and although there was much that was beyond dispute, some further work was required in certain directions to confirm some of the statements made. In the first place, the question of phosphorus had to be considered in relation to the castings being made. In light castings, such as gutters and rain-water goods, phosphorus did not matter, and a very high phosphorus content was permissible; but in heavy castings, which had to withstand high-pressure water or air tests, phosphorus became a serious problem, and it was necessary to limit the content to a low figure if the castings were to be sound. There was more in it than merely the relation between the total carbon and the phosphorus; one should consider all the elements present in any particular iron and the relation of one to the other. The Committee had dealt with carbon and phosphorus chiefly, but had mentioned only the total carbon; but it was necessary to consider not only the total amount but the condition and the distribution of the carbon present, especially the graphite.

Low-Carbon Content and Rotary Furnaces

Mr. Campion did not agree that there was necessarily difficulty in handling low total-carbon irons. In cupola melting there might be some trouble, owing to the difficulty of superheating to a sufficiently high temperature and for a sufficient length of time; but we were not confined to cupolas for melting nowadays. With the advent of the rotary furnaces of the Sesci and Brackelsberg type one could superheat the metal very highly, and submit it to that superheat for almost any length of time. He had had more than two years' experience of working a furnace of the Brackelsberg type, and there was not the slightest difficulty in handling irons with a carbon content as low as 2 per cent. This matter had to be considered seriously as affecting the physical and molecular condition of the metal. He was carrying out an extensive research into the qualities and properties of rotary-furnace melted and cupola-melted metal; the results were not yet complete, but he hoped to publish them in a Paper before the Scottish Branch of the Institute during the coming session. Through the kindness of Glasgow friends, facilities had been placed at his disposal, and the results obtained already indicated that it was necessary to modify our views as to the effect of the elements present in cast iron, both on the physical properties and the soundness of the metal.

Short Freezing Range Materials

A paragraph in the report, to the effect that if a perfectly sound casting were the only consideration the low total carbon irons could be employed, was rather puzzling. He had thought the ideal in all cases when making a casting was to secure the greatest possible soundness. Therefore, he asked for some further explanation of that result. Then it was stated in the report that the low total carbon irons were notoriously difficult to handle, on account of their high freezing points. That, he suggested, was a mis-statement; the trouble in dealing with these irons was not due to the high freezing points but the short freezing ranges. The modern trend in securing high strengths and sounder metals was in the direction of shorter freezing ranges, and in order to be able to handle them one must secure the required fluidity by superheating.

Phosphorus Limit for Soundness

MR. J. G. PEARCE (Director, British Cast Iron Research Association) congratulated the Committee on its extremely comprehensive report. Discussing the so-called dangerous range for phosphorus, he said there never had been any real theoretical reason to suppose that any dangerous range existed, and he personally had always attributed such troubles as had arisen in this connection to the difficulty of melting together, say, hematites and high-phosphorus irons to give a medium-phosphorus content, especially in indifferent melting furnaces. The point was, he suggested, that it was very difficult under those conditions to secure homogeneity. But that was no explanation of the points which Mr. Cook had raised originally, and which undoubtedly were important. There always had been cases in which quite successful medium-phosphorus irons had been made without any of these difficulties. The conclusions from the tests suggested that in order to secure soundness, *i.e.*, the freedom from inter-granular porosity, the carbon content should be below the eutectic value; and in these particular irons, which of necessity required about 2 per cent. silicon, that practically fixed the phosphorus limit for soundness. In the lower-silicon irons, which could be used quite safely in thicker sections, the phosphorus content could be increased without involving the risk of porosity. Sometimes in practical problems some very rough rule was adopted in order to keep this point in mind. One such example was that the phosphorus and silicon together should not exceed 2½ per cent. That again emphasised the fact that if the silicon content increased, the phosphorus content must be decreased, and *vice versa*. The danger lay, in fact, in having carbon in excess of the eutectic value for the silicon and phosphorus content.

Carbon Pick-up

With regard to carbon pick-up and reactivity tests, in 1929 a very capable German investigator had found very little relation between coke reactivity values and the results of gas analyses from the cupola; in fact, he had found that cokes of differing reactivity values but of similar composition and properties had given practically the same melting results in the cupola and the same results with respect to gas analysis.

The caution displayed in the report in many cases, particularly with respect to contraction and carbon pick-up, eloquently emphasised the difficulty which investigations of the kind dealt with presented. The difficulty was rendered still greater when such work was done in individual plants where the conditions inevitably varied from point to point throughout the industry. The Committee was fully justified in adopting its very cautious attitude.

The 321/28 Specification

Discussing the 321/28 Specification, Mr. Pearce said that in testing the 2.2-in. bar he had found the supports and the loading point, even when very fully rounded, digging into the bar. But very careful measurement had shown that the amount of error introduced by that into the deflection measurement was not very considerable; he had investigated the matter in connection with a number of large bars and had found that it was not really serious. Whilst he would not regard that as an argument for abandoning the round bar, he did consider that the use of the big bar was one of the matters which should have first attention when the Specification was reconsidered. The original test-bar Committee had always regarded it as anomalous, and had recognised that sooner or later it would have to be modified radically.

Phosphorus Content and National Resources

MR. JOHN SHAW, who also congratulated the Committee on its very valuable work, said there was little doubt that, under the conditions obtaining and with the type of casting examined, total carbon and phosphorus were the dominating elements to control the form of porosity investigated. It must be remembered, however, that the greater part of British pig-irons contained phosphorus from 0.8 per cent. to 1.5 per cent. Were we to accept it as proved that castings of unequal thickness could not be made from these irons, free from porosity, except by making large additions of either steel scrap or hematite and so reducing the phosphorus to approximately 0.3 per cent.? In order to reduce the phosphorus content from 1 to 0.3 per cent. there must be an addition of about 60 per cent. of steel or hematite to the charge. Either would have a large effect on the total carbon. Many castings with irregular sections had to withstand a water test, but the price prohibited the use of refined pig-irons therein. In any case, all castings should be sound. If the Committee would investigate the possibilities on this point it would be very helpful.

Turning to the physical tests, he deprecated strongly the common practice of casting the large L bar from a mixture which was suitable only for thin castings. No other single factor had done more to prejudice engineers against the use of cast iron than had the supposed abnormal drop in strength per sq. in. with increase in section. As an example, he referred to Fig. 14, where there was a decrease from 19 tons on the S bar to below 10 tons on the L bar. It would be just as truthful to say that when using a mixture suitable for a 3-in. thick casting that would give either a mottled or white S bar, with a consequent drop in physical properties; that cast iron increased in strength per sq. in. with increased thickness and was unsuitable for thin castings, because it was brittle and unmachinable. If one wished to investigate the effect of phosphorus on an iron for thick castings, one should use a suitable base material to start with. He uttered a warning, also, against drawing definite conclusions from the use of ferro-phosphorus to make the additions, because it was his personal experience that a different structure was obtained by this method.

Problem of Carbon Pick-up

In tackling the problem of carbon pick-up the Committee was doing useful work, but the problem was full of difficulty. MacKenzie, in his Paper before the Institute in 1927, had stated that temperature and time of contact with

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* FOUNDRY TRADE JOURNAL, June 28 and July 12, 1934.

carbon were two of the principal points in connection with carbon pick-up. There was a tendency for all mixtures to come to the same carbon content, dependent on type of coke and blast. Also, depending on the type of coke, carbon pick-up would continue after each successive melting until equilibrium was reached. With high-carbon pig-iron an actual loss was sustained until equilibrium was arrived at. The question of a hot hearth was of vital importance. The bed might be well burned through, but the hearth might remain comparatively cool, due, say, to being idle over the week-end, extra daubing or wet bottom sand.

Foreign Specifications of Cast Iron

Coming to Specification 321, he said that whilst there might be a desire to add another grade of higher strength, the weakness of the Specification, in the opinion of many people, was the large variation of thickness covered by the 1.2-in. diameter bar. This was the result of a compromise to meet the capacity of the many testing machines in use at the time the Specification was drafted. Many now felt that the introduction of a bar of $1\frac{5}{8}$-in. dia. would give a more correct idea of the structure and strength of casting about that thickness. Admittedly, it was foolish to sacrifice the principle to the machine. Dealing with the references to German and American specifications, he said the former, whilst recognising the principle of fixing the diameter of the test-bar so that it would bear some near relation to the thickness of casting it represented, stopped short at the 1.2-in. dia. bar. This represented all castings more than 1 in. thick. The American tentative specification A48-32T varied from the British, for the large bar was fixed at 2-in. dia. and tested at 24-in. centres. The span was increased to give a truer measure of the deflection. But some recent work by MacKenzie on the effect of difference in span had shown that there was little difference on the 2-in. bar between the 18-in. and 24-in. span, and it would appear that the Americans had merely harassed themselves by using a more cumbersome bar.

Again, the Americans had graded their material in terms of minimum tensile strength. Starting at 20,000 lbs. per sq. in., they had run up, with increments of 10,000 lbs., to 60,000 lbs. per sq. in. No difference was made between the S and L bars in this respect. The transverse tests were optional, but might be specified. The idea behind the alteration was that the customer might specify a definite strength, for which a price would be quoted accordingly. How far this would work out in practice remained to be seen, however; probably the engineer would require the high-test material, whilst the buyer would want to pay the lower price.

The Committee had definitely adopted the method of expressing transverse strength as transverse rupture stress. How far this would be acceptable to inspectors and engineers was open to question; they generally wished to see the actual breaking load, without going to the trouble of converting it into something else. There was an example of this kind in the recently-attempted introduction of the 24-hr. clock. Another objection to the method was the possibility of the same modulus figure being asked for from the L bar as from the S bar. If cast iron were a homogeneous material, that would be reasonable.

The Danger Range in Phosphorus Content

MR. F. J. COOK (Past-President), after commending the work of the Sub-Committee, said he had never stated dogmatically that there was a danger range at about 0.5 per cent. phosphorus content because he had never been able to satisfy himself that it existed or that there was a reason for it. But during the last forty years he had experienced very remarkable troubles with castings, particularly in the development of hair cracks, where there was 0.5 per cent. of phosphorus in the composition, and they had been eliminated, so far as he could judge at the time, by raising the phosphorus content. The argument he had had in mind was that the troubles were due to contraction strains, and that by increasing the phosphorus one decreased strains of that description. Those experiences he had referred to the Committee, and he had no fault to find with the conclusions arrived at, that no reason could be found as to why this particular trouble should occur. He also did not know the reason. But when there were many examples, over a period, which had exhibited this particular trouble and where it had been made to disappear immediately, one had to see how far there was anything in it. The question had arisen in two ways—how far phosphorus affected the porosity of a casting and how far it affected the physical strength. He had merely stated the facts and had suggested that there was probably some definite reason for the particular change referred to. He believed it was Bolton, in America, who had pointed out that there was a distinct change at 0.5 per cent. phosphorus, that at below 0.5 per cent. It was mainly as a solid solution, but some of it was as a compound, whereas above 0.5 per cent. it existed entirely as a compound. If that were true—and Mr. Cook could not believe it altogether—it indicated that there was some change at that particular point. He did not believe that phosphorus *per se* was wholly responsible for the variations in the strength of a casting; the factor that mattered was the total carbon, *i.e.*, the balance of the total carbon and the silicon, or how near was the approach to the eutectic point. He believed he had proved many times that round about, or just below, the eutectic point it did not matter at all how much phosphorus was present; he had proved it in large Diesel-engine pistons, of 22 and 24 in. dia., in which, it was usually considered, phosphorus was absolutely detrimental. The phosphorus was only detrimental, he believed, when the carbon was off the range of the eutectic, or when there was not a balance between the carbon and phosphorus, and he had proved it by raising the phosphorus content in the pistons referred to. He had aimed at 1.5 per cent., but had obtained about 1.4 per cent. If the theory with regard to high phosphorus content were true, then those pistons ought to have cracked within about half an hour, but in fact they had been at work

TABLE A.—*Initial Pouring Temperature, 1,340 deg. C.*

Casting section:	Green sand.					Dry sand.				
	¾ in.	1 in.	2 in.	3 in.	4 in.	¾ in.	1 in.	2 in.	3 in.	4 in.
Temperature of test section immediately after pouring deg. C.	1,100	1,140	1,160	1,180	1,190	1,100	1,150	1,160	1,200	1,210
Temperature of solidification, deg. C.—										
Beginning	1,100	1,125	1,110	1,110	1,120	1,090	1,120	1,130	1,150	1,120
Final	1,085	1,100	1,100	1,100	1,100	1,070	1,100	1,100	1,100	1,100
Time of solidification after pouring in minutes—										
Beginning	Nil	½	1	2	2	½	1	1	2	3
Final	2¾	4	9	13½	20	3	4	8½	13	18
Cooling time in minutes to reach carbide change point—										
Beginning	13½	16½	33	48	72	12½	16½	30	51	63
Final	18	21½	43	61½	81	17½	22½	41	65	92
Temperature of carbide change point, deg. C.	720	750	730	730	740	718	750	740	740	745
Cooling time in minutes to reach 600 deg. C.	24	32½	58½	86	115	24	35½	57	100	138
Analysis—										
T.C.	3.46	3.53	3.53	3.55	3.20	3.53	3.48	3.64	3.54	3.49
C.C.	0.60	0.65	0.55	0.55	0.53	0.65	0.58	0.55	0.55	0.67
Si.	1.69	1.41	1.64	1.5	1.83	1.69	1.50	1.36	1.55	1.73
Mn.	0.87	1.24	0.86	1.09	1.16	0.90	1.16	1.36	1.22	1.17
S.	0.125	0.101	0.129	0.185	0.102	0.125	0.115	0.093	0.137	0.092
P.	0.40	0.27	0.28	0.28	0.30	0.49	0.47	0.27	0.33	0.24

NOTE.—All gates and risers normal to general foundry practice.

since about the middle of the war period. Again, he had proved that with 1 per cent. of phosphorus in the mixture one could produce castings of 18 or 19 tons tensile if one maintained the balance referred to; otherwise, the phosphorus became dangerous. Therefore, he suggested that the Committee should consider further the carbon content as well as the phosphorus content.

Convener's Reply

MR. P. A. RUSSELL (Convener of the Sub-Committee), replying to the discussion, assured Mr. Campion that the Sub-Committee had been thoroughly aware of the importance of the size and distribution of the graphite, and had endeavoured to overcome difficulties in this respect by maintaining the conditions as standard as possible, by using the same grade of pig-iron and the same melting processes as far as possible. Indications were given as to where irons were cupola-melted and where they were crucible-melted, and it was a fact that the tendencies exhibited were very much less marked in the crucible-melted series than in the cupola-melted series; the curve was very much steeper in the case of the cupola-melted than the crucible-melted iron. In the section of the report dealing with conclusions from physical tests, the Sub-Committee had covered the point particularly with regard to physical properties.

With regard to the request for a definition of "porosity," he said the Sub-Committee had had to define it largely by what it was not, and he believed the definition given was the best that could be arrived at for the form of porosity examined—that which occurred as irregular internal voids in a casting, of the type illustrated in Fig. 6.

The Sub-Committee had done no macro-etching.

He agreed with Mr. Campion about the importance of superheat and the importance of the low-total-carbon irons. The remarks of Mr. Campion bore out the Sub-Committee's contention that if the total-carbon content were low, one need not bother about phosphorus, and that at well below the eutectic the phosphorus did not matter.

With regard to the statement in the report, that if a perfectly sound casting were the only consideration the low-total-carbon irons could be employed, and Mr. Campion's criticism that a perfectly sound casting should be the only aim, Mr. Russell said that surely there were considerations other than perfect soundness in certain classes of castings, particularly those which were not exposed to severe conditions. Some castings, though not definitely free from porosity, were quite good enough for their duty. The Sub-Committee's point was that it was useless introducing a number of difficulties for the foundry by insisting upon perfectly sound castings in every case if soundness were not definitely necessary.

Replying to Mr. Pearce, he said the Sub-Committee had had in mind all along the importance of the eutectic point, and he had been to much trouble in an endeavour to correlate all the data to the eutectic point, but it had resulted in a hopeless tangle, and the Sub-Committee could not correlate it definitely to the eutectic point alone; there seemed a definite break at 0.3 which was not connected solely with the eutectic.

The remarks concerning carbon pick-up would be referred to the Sub-Committee for consideration, and the references to the specifications had also been very helpful.

The reference by Mr. Shaw to the predominance of high-phosphorus pig-irons in Britain was appreciated, and it was necessary to bear in mind that we must use the high-phosphorus irons if we could. He believed the solution lay in employing low-carbon contents with the high-phosphorus contents.

One was inclined to agree with Mr. Cook that possibly the development of hair cracks was related to contraction, the phosphorus having some effect upon that contraction; but the Sub-Committee had been unable to investigate the point.

Vote of Thanks

MR. J. E. HURST (Senior Vice-President), speaking as an individual member of the Sub-Committee, expressed appreciation of Mr. Russell's convenership. No one who was not a member of the Sub-Committee, he said, could really appreciate the extraordinary amount of work that Mr. Russell had done, not only in organising meetings in all parts of the country, but also in summarising the work and in preparing the present report. It was hoped that the production of the report would be regarded by him as some compensation for his work.

MR. W. WEST (also a member of the Sub-Committee), who seconded, said that Mr. Russell had attended every meeting, and, judging by the volume of correspondence between himself and the members, he must have spent a great deal of time in the compilation of the information forwarded to him.

The vote of thanks was accorded with acclamation.

Effect of Pouring Temperature

MR. F. HUDSON (member) wrote that there were two points in this excellent report upon which he wished to comment. In the first place, regarding the effect of pouring temperature on shrinkage, he had been interested in this matter for some time, and the experimental results published in Table A might help to shed additional light on this subject. In conducting these tests the object was to obtain some idea as to the effect of green- and dry-sand moulding upon the properties of various sectioned castings. Apart from the results obtained in this direction, it is interesting to observe that when using an initial pouring temperature of 1,340 deg. C. the actual temperature of the green-sand casting with $\frac{3}{4}$-in. section is 1,100 deg. C., the beginning of solidification for iron of the composition used. This result was quite unexpected and illustrates the large temperature drop between pouring temperature and true casting temperature. He suggested that this point should receive further consideration in any future study of this question. It clearly indicated the futility of results based on pouring temperature alone.

The second point concerned test-bars and B.S.I. Specification 321/28. In the transverse test on the largest size bar the capacity of many machines was insufficient to effect fracture, and it would be a good thing if the breaking centres could be extended to permit of lower breaking loads being applied, and a correction factor determined for the correction of such results for direct comparison with the existing standards. If such a factor could not be arranged, then he would suggest a definite alteration in the specification on this point.

The L-Bar Deemed Unsuitable

DR. J. W. DONALDSON wrote that he had read the report with considerable interest, particularly as he had been a member of the Cast Iron Sub-Committee in its earlier stages. He was glad to see how the work had developed and he wished to congratulate the members on this report of their work.

The bulk of the report was occupied by work on the porosity and strength of cast iron in relation to the total-carbon and phosphorus contents. He was pleased to note that so far as porosity was concerned the Committee had come to the conclusion that composition was of importance and that a greater range of silicon and carbon was permissible, when using low phosphorus. He was particularly interested in irons for Diesel-engine work and at one time considered that, if the phosphorus content did not exceed 0.7 per cent. such irons were satisfactory. As the result of experience, however, he now favoured irons which had a low-phosphorus content and seldom specified more than 0.3 per cent. in irons containing 3.30 per cent. total carbon and 0.85 to 1.3 per cent. silicon.

With regard to the influence of phosphorus on the strength, he was glad the Sub-Committee had emphasised the necessity of considering the total carbon, when discussing the existence of a dangerous range and the phosphorus content. This was a point which was of importance and was sometimes inclined to be overlooked.

The Sub-Committee had referred to the B.S.I. Specification 321/28. He approved of the Specification in general and had no difficulty in the breaking of round bars. He agreed, however, that the "L" tensile bar was unsuitable. Regarding the grades, he could never understand why these were labelled "A" and "C," and certainly thought that specifications of higher strength should be adopted, more in line with the present Admiralty Specification. He considered that the present grades were perhaps one of the reasons why the specification was not more generally adopted. As regards expressing the transverse strength as transverse rupture stress, he was in full agreement, but realised that considerable difficulties exist in persuading designers and users to adopt such a term.

Condition of Phosphorus Content

In the report, two M bars with high phosphorus give very high transverse figures, and there is sometimes a dangerous range with 0.5 to 0.7 per cent. phosphorus. These facts bring out very clearly that phosphorus is like graphite. The form is all-important (or almost so) and the amount of secondary importance.

Phosphide can occur as two eutectics—as network either fine and continuous or coarse and irregular, or even liquated and "balled up." Silicon has a great influence on the *form* of the phosphide. It is not until careful micrographic comparison of the forms of phosphide are taken into account that these results will be clarified. It is already done for graphite—why not phosphide?

Stainless Steel Merger

AGREEMENT BETWEEN FIRTH-BROWN AND ENGLISH STEEL CORPORATION

Messrs. Thos. Firth & John Brown, Limited, and the English Steel Corporation, Limited, announce that a preliminary agreement has been entered into for the formation of a new company to acquire as from October 1, 1934, their respective businesses as producers of stainless and Staybrite steels. The agreement will require the consent of the debenture stockholders of Thos. Firth & John Brown, Limited.

The new company will be called Firth-Vickers Stainless Steels, Limited, and Thos. Firth & John Brown, Limited, and the English Steel Corporation, Limited, will each hold one-half of the subscribed capital. The board of the new company will be appointed by the two parent companies, and Mr. A. J. Grant will be the first chairman. This arrangement is confined to stainless and Staybrite steels, and will not affect the other activities of the parent companies.

Cleveland Blast-furnacemen's Wages

The net average ascertained price of No. 3 Cleveland G.M.B. pig-iron for the second quarter of the year is officially announced to be 55s. 2.15d. per ton, which compares with 53s. 11½d. per ton in the first quarter. Under the special arrangement the Cleveland blast-furnacemen's wages will remain unchanged during the ensuing three months, during which period they will continue to be paid 5 per cent. above the standard base rates.

Orders for Steel Pipes

The South Durham Steel & Iron Company, Limited, who have already executed two big pipe contracts for the Grampian Electricity Supply Company, Perthshire, have booked through Messrs. Balfour, Beatty & Company an order for a further 1,000 tons of steel pipes for the same company. These will be manufactured at the firm's Stockton pipe works, where work is now in progress on a similar contract for the North Wales Power Company.

XUM

The German Foundrymen's Association

The annual meeting of the German Foundrymen's Association, der Verein deutscher Giessereifachleute, which was held this year from May 25 to 27 in Berlin, served a twofold purpose, for, in addition to constituting the usual annual congress of German foundrymen, the occasion also marked the celebration of the 25th anniversary of the foundation of the Association. A special programme was arranged, and commenced with a series of Papers on various aspects of the foundry technology and practice, the principal of which are reviewed below. On Saturday, May 26, the members and visitors were given a public welcome at the Berlin City Hall by the Mayor of Berlin, Dr. Sahm, and on Sunday, May 27, the proceedings were continued, being introduced by a special performance of the prologue from "Die Meistersinger." At this meeting, the chairman, Dipl.-Ing. W. Bannenberg, after delivering an address of welcome to all visitors, gave a survey of the evolution and activities of the Association during its first quarter-century of existence. Further to commemorate the occasion, it was decided to institute an Adolf-Ledebur Memorial Medal, in memory of one of the greatest masters of foundry technology in Germany, such medal to be awarded to outstanding personalities in the foundry industry. The first award of the medal was made conjointly to Karl Emmel of Hemer and Karl Sipp of Mannheim.

ABSTRACTS OF PAPERS

White-Heart Malleable

DR.-ING. K. ROESCH read a Paper on "German White-heart Malleable Iron as a Material in Machine and Plant Construction," in which he surveyed the composition of the principal classes of white-heart iron on the basis of the Maurer cast-iron diagram, and outlined the various annealing processes, with special reference to the effect of sulphur, silicon and manganese on the decomposition of cementite. It had been found, said the author, that the temperature of graphitisation was reduced by about 10 deg. per 0.1 per cent. Si, by about 50 deg. per 0.1 per cent. S, and by about 10 deg. per 0.1 per cent. Mn. An analysis of the chemical reactions in the annealing process of white-heart iron enabled the author to explain the causes of the principal defects found in these irons. Dr. Roesch also discussed means for reducing costs and the time required in the annealing process, which was made very costly by the high temperatures and long heat-treatment required. The rapid annealing process which usually starts from materials with an increased Si content and a reduced carbon content has not proved very satisfactory in practice, as the hard casting presents various practical difficulties, and also since the process is too cumbersome for continuous operation. Better results are obtained with modern annealing furnaces, which, although not shortening the time of treatment, yet make a marked saving in fuel.

Turning to the mechanical properties of white-heart malleable iron, the author emphasised that, by giving careful attention to the annealing process, it was possible to obtain physical properties enabling the material to be used for highly-stressed constructional members, as, for instance, in automobile construction. The reason for the lack of confidence in this material is that existing standards do not place it in a favourable light as compared with black-heart malleable iron; the standards governing these materials require careful revision.

Soundness of Cast Iron

DR.-ING. A. VÄTH, in his Paper, discussed the composition and properties of cast iron, and pointed out that the principal defects in grey castings are:—(1) Blowholes, (2) hard spots, (3) abnormal hardness and physical values, and (4) abnormalities in structure. Dealing with the four classes of structure as determined by the rate of cooling, *viz.*, metastable, eutectic graphitisation and ferritic ground mass, normal pearlitic, and a ground mass containing coarse graphite and ferrite, the author pointed out that all four structures can be detected in the cast wedge, and that a desired structure can only be obtained by a careful control of the cooling conditions. Especially important is an observation of the development of the eutectic structure, which, in addition to causing the formation of eutectic graphite, also gives a soft ferritic ground mass, which in castings frequently causes a hardness transformation, such that thin-walled portions have a lower hardness than thick-walled sections. At these places the graphite is veined and the ground mass usually reveals much pearlite. The thickness of the eutectic layer is determined by the superheating and a critical rate of cooling, which latter is most marked in thin-walled castings high in nuclei. It is highly important for the foundryman to know the tendency of a cast iron to pipe, which property is certainly also affected by the graphite, since cast irons containing coarse graphite particles have a marked tendency in this direction. The gas content of the melt also determines piping, as may be shown experimentally. To obtain a high-grade grey casting, the melting conditions must be carefully controlled, especially the superheating, which latter is counteracted by the silicon content, although its effect on graphitisation can be considerably restricted by advanced superheating. Superheating makes the graphite much finer and refines the texture of the iron, while critical superheating produces eutectic graphite formation. Another factor affecting the appearance of defective places is the shape of the casting and the arrangement of the moulds and patterns, especially where the wall thickness is not uniform, which readily results in draws and an uneven texture.

Fatigue Strength of Cast Iron

DR.-ING. C. PFANNENSCHMIDT read a Paper on the fatigue strength of cast iron and its bearing on structural and surface characteristics, in which he reviewed current theories, practical tests and their relationship to the improvement of the mechanical strength of cast iron.

Commemoration Volume

The Verein has also marked the occasion of its 25th anniversary by a handsome commemoration volume or Festschrift, of which a copy has been kindly sent us. Well printed, although in Gothic characters, on fine paper, this volume is a splendid production, and will help to focus the attention of associations of foundrymen throughout the world on the history and activities of their fellow association in Germany. The work is arranged in two sections, the first containing the following:—Development and activities of the Verein; a list of founder members and the early history of the Verein; a graph showing the growth of the Verein; lists of honorary members, and council members, etc.; and a roll of honour of leading foundrymen who fell in the war. This section also contains a number of full-page photographs of eminent foundrymen with biographical details. It is interesting to note the growth of the membership of the Verein, which in the year of its foundation—1909—numbered 29 members. This number increased linearly to 500 by 1914, then dropped to 395 in 1916, when a steady and continuous increase took place up to 1924, in which year the membership numbered 1,176. The greatest increase in membership took place in the year 1922-23, from 900 to 1,153. From 1924 to 1925 there was a slight fall to 1,137, when a further period of expansion to 1930 commenced, the membership in that year reaching the record level of 1,630. From 1930 to 1933 there was a steady decline to 1,462, while the current year has seen a slight recovery to 1,487. The strength of the Verein and its growing importance in the industry in Germany are well illustrated by these figures.

The second section of the volume is devoted to historico-technical Papers surveying developments during the last quarter of a century in the following branches of foundry technology; melting practice in foundries; cast-iron research; German steel foundries; development of the malleable-iron industry; foundry technology and practice; foundry machinery; moulding-sand testing; developments and improvements in drying practice; testing of cast iron; labour questions; and the training of foundry apprentices and skilled labour in foundries. Each Paper in this section is written by an acknowledged specialist, and the section concludes with an article entitled "Duties of the Engineer as a Works and Industrial Leader in the New Reich." This introduction of political questions into a purely technological field such as foundry practice is the only fault marring an otherwise excellent and praiseworthy production, which other foundry associations of greater age could do worse than to emulate. We take this opportunity of expressing our congratulations to the Verein deutscher Giessereifachleute on this fine commemoration volume, and all our best wishes for its future expansion and increasing influence in binding the German foundry trade together.

Catalogues Received

Moulding Machines. Messrs. Foundry Equipment, Limited, 17, Victoria Street, London, S.W.1, have sent us a four-page leaflet which illustrates and describes TB1 a boxless high-speed moulding machine. It has been designed for the rapid manufacture, using hydraulic power, of moulds taking double-faced pattern plates of shallow castings. It rams both top and bottom parts simultaneously, with a downward stripping of the rammed moulds, which are "boxless." The size of the mould is either 17 in. by 12 in. or 17 in. dia., the ramming pressure is 750 lbs. per sq. in. and the approximate weight of the machine is 1½ tons. The machine is covered by Patent Application No. 10950/34 and is claimed to be the fastest machine of its type—that is, for the manufacture of shallow castings.

Collodial Clay. Considerable information about the occurrence, nature and properties of Bentonite is disclosed in a pamphlet received from Quest Products, Limited, of Winsford, Cheshire, and P.O. Box No. 1, Solihull, Birmingham. It seems that Bentonite is a decomposition product from lava formed during the Paleozoic Age, and corresponds to a formula of Al_2O_3, $4SiO_2$ x H_2O, as against China clay which is Al_2O_3, $2SiO_2$, $2H_2O$. The latter, however, is 50 times as coarse as Bentonite. It is apparent that colloidal clays are making real progress as a bonding material in British foundry practice.

Mysore Ironworks

The board of management of the Bhadravati Ironworks, in Mysore, after a prolonged discussion of the question whether the works should be closed owing to the loss incurred, have decided that only a steel plant could save the works and prevent further loss. Accordingly, the board has recommended to the Mysore Government that an order be placed for a steel plant. It is understood that the Government has accepted the recommendation and an order for the plant will be placed shortly.

Mass Effect and Quality in Steelmaking

SIZE AND DESIGN OF HEARTHS

MR. JOHN H. HRUSKA, writing in a recent issue of "The Iron Age," states that, in comparison with other phases of human activities, the sequence of fundamental advancements in ferrous metallurgy is generally considered a fair criterion of the existing tendencies, especially in steelmaking. With this in mind, some significance may be accorded to the peculiar fact that a period of about 30 years prior to 1900, or perhaps 1903, gave all the major steelmaking principles to the metallurgical world, while since then, *i.e.*, in another period of 30 years, no distinctly new process has been discovered. Oddly enough, the advent of the almost spectacular research and systematic experimentation in metallurgy coincides just with these latter 30 years. Judging from present knowledge on the broad subject of metallurgy, one must nevertheless be impressed by the strides made during the last few decades. Scientifically-accurate process and material control have since dominated the field of management to such an extent that the long years of experience required in the past, even for the production of ordinary grades of steel, are outdistanced by the judicious application of comparatively-simple scientific principles. The design of furnace hearths and quality of the ultimate product were two factors the relationship of which was perhaps the most puzzling of all problems confronting the practical man, ever since the advent of contemporary methods of steelmaking.

Reaction Surface and Ratios

The problem of metallurgical reactions in connection with furnace characteristics may best be comprehended when compared with experiences gained from the simplest chemical experimentation. In order to illustrate subsequent statements, one should recall, for example, the addition of an aqueous solution of some hydroxide containing some phenol-phthalein indicator to an aqueous solution of nitric acid, the first of the solutions being in excess. If the test is made in a very narrow test tube ($\frac{1}{4}$-in. I.D., for instance), it will readily be noted that the pink colour of the added hydroxide solution will not reach the bottom of the tube, thereby indicating that the reaction occurred only near the surface of contact between both solutions. A repetition of the same experiment by using the identical concentrations and amount of the reagents, but by pouring the solutions into a flat glass container (beaker, casserole, etc.), will show that the pink colour covers the entire contents almost instantaneously. In both cases the chemist will write the identical equation for the occurring reaction; but why was the reaction incomplete in the tube, and why did it proceed so quickly in the flat vessel? Disregarding highly-technical or even hypothetical explanations for this phenomenon, it is apparent that the surface of possible contact of the two phases was small in the first experiment, whereas in the second case a large area of contact made a speedy reaction possible. Not even stirring with a fine platinum wire accomplished the desired result in the narrow container. When applying this principle to reaction velocities in the production of modern steels, one must bear in mind that the molecules of fluid steel are much less mobile than those of aqueous solutions. Hence, reactions require more time or a larger reaction surface to their completion, *i.e.*, to equilibrium. From the same viewpoint, stirring or motion of the liquid metal will be less effective than in case of aqueous solutions. Two principal factors—besides temperature, concentration, mass and pressure—are therefore of importance to quality in practical steelmaking, viz., time and reaction surface.

In order to introduce the mass of the fluid steel into the account when dealing with metallurgical reactions, the writer has advocated a "reaction ratio," *i.e.*, the quotient.

$$\frac{\text{Bath area in square inches (A)}}{\text{Weight of metal in lbs. (Wt)}}.$$

The resulting value may, therefore, be defined as the reaction area in sq. in. per lb. of liquid steel in the respective melting furnace. The reaction ratio could, of course, be similarly expressed as the quotient of

$$\frac{\text{Reaction surface in square feet}}{\text{Weight of the metal in tons}}.$$

Quite naturally, any deductions from these expressions must be identical for either of the two methods. It appears from an extensive study of available data on various heats that maxima of deviations for contemporary processes of steelmaking range from about 0.14 to 1.46 sq. in./lb. Realising the similarity of many thermo-chemical reactions in the commercial production of iron and steel (decarburisation, desulphurisation,

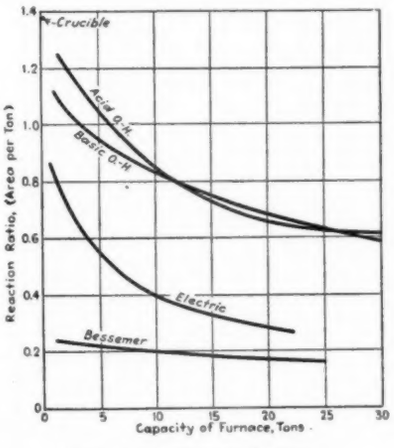

FIG. 1.—REACTION RATIOS.

etc.), the lower of these limiting values seem to be indices of so-called tonnage steels, while the higher figures are characteristics of quality products. The extent of these variations for the principal processes is shown in Table I. Since all values given in the tabulation are based on actual determinations made under normal works routine, any conclusions derived from these data are indicative of modern melting technique and may, for these reasons, be generalised. Consequently, several new aspects upon steel-making may be gained by scrutinising the values. No metallurgist ever questioned the superiority of crucible and electric steels over grades made in large open-hearth or Bessemer furnaces, *i.e.*, on a heavy tonnage basis, and yet very little or no satisfactory explanation for this reality was ever offered either by research or the metallurgical profession. This fact becomes especially significant when steels are produced in small melting units and simultaneously in large furnaces, but of practically identical chemical composition. The grades manufactured in the small units (viz., under a high reaction ratio) are invariably of better quality.

Many a formerly perplexing problem seems capable of being clarified by the introduction of what has been designated as "reaction ratio." One may only refer to the many contradictory reports on the physical and metallographical properties of acid *versus* basic steels, which dispute has not been settled to mutual agreement—although exceptionally large sums were spent since the war to dispose of this very important metallurgical case. A little study of Fig. 1 (states the author) will amply prove this contention. Considerable argument may be expected on the general applicability of reaction ratios in metallurgy. Thus, for example, to the chemist they may be meaningless, because none of his formulæ, equations and calculations incorporate any effects of reaction surfaces nor actual masses entering chemical reactions. This is especially true of thermo-chemical reactions occurring at such high temperatures as in the fabrication of ferrous metals. To the steelmaker, however, they are undefined facts of everyday experience; he knows that fine steels can, under existing conditions, be produced only in furnaces of a very limited capacity. So far he did not have any explanation for it. The metallurgist suspected, from deliberations on thermo-dynamics, thermo-chemistry and simple shop practices, that some fundamental basis must exist between the characteristics of melting

TABLE I.—*Characteristics of Heats made in Various Steel-making Furnaces.*

Melting furnace.			Reaction surface for specific heat.	Reaction ratio for the same heat.*
Type.	Lining.	Nominal capacity.	Sq. in.*	
Crucible ..	Clay ..	90 lbs.	126	1.371
,, ..	Graphite	100 lbs.	131	1.192
High-frequency electric ..	(Actual data not available)			
Electric arc	acid ..	0.5 ton	1,045	0.862
,, ..	basic ..	3 ton	4,210	0.600
,, ..	acid ..	6 ton	7,208	0.522
,, ..	basic ..	7 ton	7,420	0.470
,, ..	basic ..	10 ton	8,750	0.382
,, ..	basic ..	25 ton	15,100	0.253
Open-hearth	acid ..	1 ton	2,740	1.250
,, ..	basic ..	8 ton	14,610	0.830
,, ..	acid ..	10 ton	20,400	0.849
,, ..	acid ..	15 ton	22,800	0.712
,, ..	basic ..	20 ton	31,700	0.741
,, ..	acid ..	25 ton	34,700	0.654
,, ..	basic ..	25 ton	20,400	0.464
,, ..	acid ..	30 ton	42,000	0.653
,, ..	basic ..	50 ton	58,350	0.488
,, ..	basic ..	60 ton	69,200	0.487
,, ..	basic ..	120 ton	103,600	0.337
,, ..	basic ..	200 ton	105,100	0.221
Bessemer ..	acid ..	2 ton	905	0.220
,, ..	acid ..	15 ton	6,050	0.184
,, ..	acid ..	25 ton	8,150	0.147
,, ..	basic ..	16 ton	6,450	0.198

* All figures given above are based on actual determinations and not on nominal capacities.

equipment and the resulting physical properties of the product. Many mechanical, chemical and magnetic phenomena in ferrous matter point distinctly toward some basic law governing apparently all metallurgical processes and properties of iron and steel.

The very recent work of Albert Portevin, Professor of the Ecole Centrale at Paris, on the thermo-dynamics of the refining periods of steelmaking processes is in full accord with the foregoing deductions. Thus, the velocity of metallurgical reactions between liquid phases is predominantly a function of strictly-chemical reactions (*i.e.*, the difference of composition of the phases prior and at equilibrium), the area of contact surface and of the movements of the molecules as well as of the viscosity of the phases, which latter naturally depends upon the temperature of the bath and its composition. Excepting the chemistry of steel-making processes all other items are inherent to the individual melting procedure.

(*Concluded on page* 50.)

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Alloys Research Committee

A CONSIDERATION OF ALLOYS OF IRON

DR. C. H. DESCH recently presented a Paper on "The Work of the Alloys of Iron Research Committee" to the Institution of Mechanical Engineers for written discussion, in which he reviewed the history of the Committee, and pointed out that the Alloys Research Committee of The Institution of Mechanical Engineers began its work in 1890; from 1902 onwards the investigations were conducted in the National Physical Laboratory. Iron was probably more sensitive to the influence of minute quantities of impurities than any other metal so far studied. This fact introduced special difficulties into its metallurgical investigation. Owing to its high melting point, it was particularly liable to absorb impurities from the containing vessel or from the atmosphere during melting, so that precautions had to be taken to exclude gases and to provide vessels of chemically-inert material. These precautions themselves made it necessary to carry out difficult and often tedious investigations before the actual study of a system could be begun. The new experimental methods thus devised were found valuable by other workers, so that quite different branches of metallurgical practice and research derived benefit. Several such by-products of the study of alloys of iron were referred to towards the close of this Paper.

Preparation of Pure Metals

An important part of the work (states the author) has been the preparation of the component metals in a state of sufficient purity for accurate study. Iron, for the reasons mentioned above, is one of the most difficult of all metals to purify. The commercial varieties of iron all contain sufficient impurity to modify their properties to a very appreciable degree. Pure iron is as soft as copper, and very minute quantities of added elements harden it appreciably. For the preparation of iron as used at the National Physical Laboratory, the method of electrolytic purification has been employed, a solution of purified ferrous chloride being electrolysed with an anode of ingot iron. The product is melted *in vacuo* and then in hydrogen to remove oxide, a final melting *in vacuo* being necessary to remove hydrogen. By such methods, metal of the following composition has been obtained, this representing an exceptional degree of purity (per cent.):—Carbon, 0.006; phosphorus, 0.001; sulphur, nil; silicon, 0.0005; manganese, nil; nickel, 0.022; copper, 0.0008; chromium, 0.003; oxygen, 0.020. As small quantities of nickel derived from the ingot iron are not removed by this treatment, a purely-chemical method has been employed in some of the recent work, the purified ferrous chloride being decomposed by steam. The oxide thus formed is compressed and then reduced in hydrogen, yielding a compact metal which is then submitted to the same series of meltings as the electrolytic product.

These methods had been used by other workers, and only called for refinements, which, however, involved much labour. It was otherwise with the preparation of some of the alloying metals. Chromium presented special difficulties, the metal used in earlier investigations having been far from satisfactory in regard to purity. Electrolytic refining was decided on, but the conditions are very different from those of commercial chromium plating, and special methods had to be devised. Using a lead anode and a rotating steel cathode, both water-cooled on account of the heavy currents employed, it is possible to obtain very pure deposits, which are then freed from oxide by heating at 1,500 deg. to 1,600 deg. C. while circulating a stream of hydrogen over the solid metal. A final melting *in vacuo* removes hydrogen, and leaves the ingot in a relatively-soft condition. The great hardness of commercial chromium is due to the simultaneous presence of oxide and of hydrogen, and the pure metal is not excessively hard.

For the preparation of manganese, neither chemical nor electrolytic methods gave a metal of sufficient purity, and advantage was taken of the volatility of this metal to purify it by distillation. At temperatures only slightly above its melting point and under low pressures, manganese may be distilled from a vessel of pure magnesia and condensed on the walls of another magnesia vessel. This can afterwards be re-melted. It is brittle, and hard enough to scratch glass. For the purification of silicon, high-temperature methods gave unpromising results, and it was found best to adopt a purely-chemical method, the commercial substance being crushed and extracted with hydrochloric, nitric, sulphuric, and hydrofluoric acids in turn, to remove the impurities, after which the material may be melted in a crucible of pure silica; it then proves to be homogeneous.

Allotropic Forms

The characteristic of iron to which it owes its power of producing alloys of widely-differing properties is its existence in allotropic forms. Iron as it is known at the ordinary temperature changes the arrangement of the atoms in its crystals at a little above 900 deg. C., and then, curiously enough, reverts to the original structure at 1,400 deg. C. Between these two limits, γ-iron, as it is called, has the property of dissolving foreign elements, especially carbon, to a much greater extent than the low-temperature form, α-iron, or the high-temperature δ-iron, which is identical in structure with α-iron. It is by quenching within the γ-range that steels are hardened, the effect of rapid cooling being to suppress a part of the changes which normally occur, giving rise to a hard structure known as martensite. Alloying elements alter the conditions in two ways: by altering the width or position of the γ-range, and by delaying the process of change. Some elements are so potent in this latter direction that a steel containing them will assume the hard condition even when cooled at a moderate rate in air, and have to be slowly annealed to produce the normal or relatively-soft structure. Such steels are said to be air-hardening. The austenitic steels are those in which the effect of the alloying elements has been to make the γ-condition stable at ordinary temperatures. γ-iron being non-magnetic, austenitic steels also have that property, and the production of even small proportions of α-iron in them is shown by the appearance of magnetic properties. This is important as a means of investigation. A redetermination of the melting point of iron of the degree of purity obtained in the National Physical Laboratory gave a value of 1,527 $\pm$ 3 deg. C.

The author then outlines some of the chief phases of work done, including investigations on alloys of iron and oxygen, iron and phosphorus, iron and silicon, iron and chromium, and iron and manganese.

Chromium and Manganese-Iron Alloys

The alloys of iron and chromium are the basis of the rust-resisting steels and of most of the special steels intended for use where exposure to high temperatures is a necessary condition. The so-called "stainless iron" consists essentially only of iron and chromium, whilst carbon, nickel, and other elements enter into the composition of the special chromium steels and alloys of the "nichrome" class. Chromium proved to have a melting point of 1,830 deg. C., a much higher figure than that previously accepted, the lowering being due to impurities, especially nitrogen. The two metals form a continuous series of solid solutions at high temperatures, and the existence of a compound, supposed by some other workers to be formed, has not been confirmed. This is one of the systems in which the added metal has the effect of suppressing the allotropic changes in iron over a certain range of composition.

The iron-manganese series is of special interest as including the earliest known example of the "austenitic" steels, namely, Hadfield's manganese steel, which contains carbon, but owes its most important properties to the special characteristics of this series of binary alloys. The system is complicated by the fact that not only iron but also manganese undergoes allotropic changes on heating, with striking alterations in crystalline structure, so that all the resources of X-ray investigation have had to be requisitioned in order to trace out their course. Manganese in relatively small quantities is an essential constituent of most steels, even of those used for structural purposes, and the proportion is increased in modern "high-tensile" structural steels and also in those which are intended to have free-cutting properties.

Concluding, the author states that it may appear strange that the next alloys calling for investigation should be those of iron and carbon, which form the basis of almost all the commercial alloys of iron, but the progress of research on steel has produced a new set of problems which call for solution, and metallurgists have urged on the National Physical Laboratory the need for a redetermination, using the highly-purified iron now available.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

21,637. DURAFER, INC. Apparatus for centrifugal metal casting. 405,292.

24,354. LINDE AIR PRODUCTS COMPANY. Welding apparatus. 405,366.

2,573. SOC. D'ELECTRO-CHIMIE, D'ELECTROMETALLURGIE, ET DES ACIERIES ELECTRIQUES D'UGINE. Manufacture of steel. 405,456.

16,582. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Electric arc-welding or heating apparatus. 405,519.

17,233. OTTO & COMPANY, GES., DR. C. Method of construction of the masonry of industrial furnaces, particularly Siemens-Martin furnaces. 405,527.

23,085. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Electric welding machines. 405,566.

18,786. KINZOKU ZAIRYO KENKYUSHO. Metallic alloys. 405,607.

21,469. SOC. D'ELECTRO-CHIMIE, D'ELECTRO-METALLURGIE, ET DES ACIERIES ELECTRIQUES D'UGINE. Dephosphorising of steel. 405,633.

33,021. STANTON IRONWORKS COMPANY, LIMITED, and WILSON, P. H. Road setts and other road-surfacing elements. 405,772.

11,908. VEREINIGTE STAHLWERKE AKT.-GES. Method of preventing coarse crystallisation at the solidification of metallic castings. 405,842.

18,831. HULIN, J., and FORD, G. Manufacture of metal wheels. 406,186.

22,689. ARMSTRONG CORK COMPANY. Coatings for metal-casting moulds. 406,582.

27,539. STURTEVANT ENGINEERING COMPANY, LIMITED, and WILLIAMS, F. W. R. Grinding mills. 406,782.

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This Week's News in Brief

Trade Talk

MESSRS. J. CRICHTON & COMPANY, LIMITED, Saltney Shipyard, Chester, are to build two tugs, with triple-expansion engines, for the Alexandra Towing Company, Limited.

MESSRS. SIR W. G. ARMSTRONG WHITWORTH & COMPANY, LIMITED, Scotswood, Newcastle-on-Tyne, have received an order from the Government of India for two Diesel-electric locomotives of 1,300 b.h.p.

A CONSIGNMENT OF 1,000 tons of cast-iron pipes was shipped from Liverpool for Alexandria on Saturday last. The pipes were made by the Stanton Ironworks Company, Limited, for the Giza waterworks in Egypt.

IT IS UNDERSTOOD that at the end of June the orders received by the Associated Electrical Industries group of companies have increased by over 65 per cent. as compared with last year. The increase in export orders is 77 per cent. and in home orders 43 per cent.

THE STEADY IMPROVEMENT in the output of pig-iron and crude steel in Czecho-Slovakia was maintained in May last, the pig-iron production being 57,200 tons, compared with 54,500 tons, and the crude-steel output 99,400 tons, against 85,900 tons in April. During the year the output of pig-iron has improved by nearly 60 per cent., while that of steel has more than doubled.

AN EXPERIMENT which may alter road-construction methods is now being carried out by the Lanark County Council Road Board on a section of the north and south highway through the moor at Newhouse. Cast-iron plates supplied by the Shotts Iron Company have been laid prior to the actual surfacing of this section. It is claimed that roads with these plates below the surfacing will not require repair so frequently. It is further claimed that the cast-iron plates will preserve the original gradient of a road.

A REMARKABLE RAID took place on the premises of Messrs. McGloughlin, art-metal workers, Pearse Street, Dublin, when three men removed the plaster casts of a bronze plaque and four reproductions of Mr. Chas. Burgess, a prominent citizen, who was shot dead during the Irish troubles of 1921. The plaque was intended for a new building to be officially opened the next day on the spot where Mr. Burgess was shot. The raiders made good their escape before the members of the firm, who were completely taken by surprise, could inform the police.

A NEW PRIVATE COMPANY, to be known as M. Porteous & Company, Limited, has been registered in the Irish Free State, under date of June 26, to carry on business as manufacturers of spades, shovels and edged tools. The new concern has a nominal capital of £5,000, divided into 5,000 shares of £1 each. The memorandum and articles of association were signed by Mr. Matthew Porteous, Templemichael Mills, Whites Cross, Cork, spade and shovel manufacturer, and Mr. Frank Porteous, ditto, traveller, and the first directors are Mr. Matthew Porteous, Prof. J. B. Butler and Mr. Gerald J. Moloney.

THE NORTH BRITISH LOCOMOTIVE COMPANY'S works at Springburn and Polmadie, Glasgow, which are busy on L.M.S. and South African contracts, are to have restricted holidays for the first time in several years. The works closed on July 12, and will resume duties on July 19. The value of the orders on hand is estimated at £500,000. Extra work has been provided for about 400 men at Springburn and Polmadie. The last-mentioned works were reopened two months ago after being closed for a long time. The L.N.E.R. locomotive works at Cowlairs, Glasgow, closed on July 13, and will resume on July 24, and the L.M.S. locomotive works at St. Rollox, Glasgow, are on holiday from July 14 to July 28.

IRISH FREE STATE TRADE RETURNS issued for the first five months of the year reveal that for the period tractor parts were exported to the value of £4,172, compared with £24,168 in the five months of 1933, though no tractors were exported in the period. Iron and steel and manufactures thereof were imported to the value of £977,628, compared with £584,811 in the first five months last year. The import of iron and steel manufactures increased in the month of May of the present year by more than £100,000, rising from £759 in May last year to £109,750 in the corresponding month this year. Railway material increased from £3,180 to £15,614 for the month; tubes, pipes and fittings, from £15,500 to £26,300; steel bars and rods, from £8,973 to £15,520.

UNDER THE Industrial Courts Act, 1919, the Minister of Labour appointed Sheriff-Principal J. M. Irvine, Renfrewshire and Bute, to act as arbitrator on the following terms of reference :—"A claim by the Scottish Iron and Steel Trades Joint Committee, on behalf of the workers concerned, that two meal half hours should be allowed and paid for to workers who are called upon to work an overshift under the appropriate clauses of the memorandum of agreement made on August 4, 1920, between the Scottish Steel Makers' Wages Association (now merged in the Iron and the Scottish Steel Trades Employers' Association) and the Scottish Steel Trades Joint Committee (now the Scottish Iron and Steel Trades Joint Committee)." After hearing the parties the Sheriff reached the following decision :—"I award that, under the agreement between the parties, where the workers are called upon to work a full overshift, two meal half-hours should be allowed and paid for in respect of the overshift." Payments under this award are effective in this week's wages, and the workers involved comprise boilermakers, blacksmiths, engineers, electricians, patternmakers and foundry workers.

Mass Effect and Quality in Steelmaking

(*Concluded from page* 47.)

Conclusions

Taking the previously-outlined facts into account, a more thorough understanding of the mass effect in steel-making seems to warrant every possible consideration. This is particularly true in regard to the selection and appropriate design of melting units for specific purposes. Comparative studies of those changes of chemical elements which are generally considered as most outstanding in the efficiency of the refining period during a heat clearly indicate the influence of hearth capacity and reaction ratio upon the final quality of the produced ingot or even foundry metal. Metallurgically speaking, deoxidation and degasification are probably the generally desirable of all reactions in the finishing of any heat of iron or steel. Both proceed markedly faster in furnaces of high reaction ratios, thereby producing a more uniform structure in the resultant metal with little or no difficulties in subsequent thermal and mechanical operations.

Contracts Open

Leeds, July 20.—116,000 ft. of steel mains, for the Town Council. The Town Clerk (Committee Department), Civic Hall, Leeds, 1.

Argentina, August 2.—7,490 metres of casing pipes, etc., for the Argentine State Oilfields Directorate. The Department of Overseas Trade. (Reference G.Y. 14,019.)

Oakham, July 28.—Supplying and laying 3,000 yds. of asbestos and 1,400 yds. of cast-iron mains, etc., for the Rural District Council. Mr. M. Mullins, consulting engineer, Southern Railway Sidings, Sevenoaks, Kent. (Fee £2, returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Joshua Hepworth & Son, Limited, 104A, Victoria Street, Bristol.—Capital £1,500. Agents for pistons, piston rings, gudgeon pins, etc. Director: J. Hepworth.

H. J. Mainwaring & Company, Limited, Back of 1 and 2, Mary Ann Street, Birmingham.—Capital £1,000. Brassfounders. Directors: H. J. Mainwaring and Mrs. A. D. Mainwaring.

Personal

MR. J. M. COLVILLE, works manager of the Dalzell Steel Works, Motherwell, has just returned from a tour in the United States, where he visited the principal steelworks.

MR. G. A. GOODWIN, proprietor of Messrs. Davies & Company, Lion Engineering Works, Abergavenny, has been appointed a Justice of the Peace for the County of Monmouth.

MR. AND MRS. JOHN DORWARD, Dundee, celebrated their golden wedding last week. Mr. Dorward, who is 73 years of age, is foreman joiner of Blackness Foundry, where he has been for 46 years.

MR. D. F. COOPER, head of the works office department of Messrs. Douglas Fraser & Sons, Limited, engineers, etc., Westbank Foundry, Arbroath, received a presentation from the staff on the occasion of his forthcoming marriage.

MR. AND MRS. JOHN WOTHERSPOON, Broomhill, Bonnybridge, celebrated their golden wedding last week. Mr. Wotherspoon, who is 71 years of age, is still following his employment as assistant foreman moulder with Messrs. Mitchell, Russell & Company, Limited, at the Chattan Iron Foundry, Bonnybridge.

MR. PHILIP BUSTEED PIERCE, a member of a County Wexford foundry firm, known throughout Ireland for their ploughs, has invented an interesting improvement in agricultural machines of the swath-turner and side-delivery-rake type. The invention, which is certain to achieve much popularity, deals with the drive and adjustment of the tines.

Wills

HAWDON, WILLIAM, formerly of Minthorpe, Yorks, ironmaster £86,540

GILLESPIE, WILLIAM, moulder, 94, Hamilton Street, Camelon, Falkirk £2,222

LEGGOTT, WILLIAM, of Worthing, late of Messrs. W. & R. Leggott, Limited, brassfounders, of Bradford £16,422

O'BRIEN, HENRY, late senior partner in the firm of O'Brien, Thomas & Company, Limited, ironfounders, Upper Thames Street, London, E.C. ... £87,873

Obituary

MR. GEORGE COWAN, who was for 20 years a foreman in Dalziel Steel Works, Motherwell, until his retirement seven years ago, died last week.

MR. JOHN LANG, of John Lang & Sons, lathe manufacturers, died last week, aged 73. Mr. Lang had completed over 50 years' service with the firm.

MR. ROBERT WILSON, who was formerly employed for many years by the Camelon Iron Company, Falkirk, died last week at his home, 3, Comely Park Terrace, Falkirk.

MR. JAMES WALKER, of Messrs. James Walker (Insulators), Limited, boiler composition manufacturers, died on July 8. He was closely associated with engineering and shipbuilding on the Clyde for many years.

Applications to Register Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"ATHRON."—Electric welding machines. Athro Company, Birmingham Road, The Hayes, Lye, Stourbridge.

"EDROW" AND "EDROWLITE."—Steel. The Earl of Dudley's Round Oak Works, Limited, Brierley Hill, Staffs.

"BRIGRAMET."—Metal for bearings. British Graphitised Metals Company, Limited, Shell-Mex House, Strand, London, W.C.2.

"PLIBRICO."—Clay for furnaces and furnace linings. Jointless Firebrick Company, Limited, Egyptian House, 170, Piccadilly, London, W.1.

"FORDAVOL."—Liquid preparation for spraying on metal-casting moulds. Fordath Engineering Company, Limited, Hamblet Works, West Bromwich.

"WELDING SUPPLIES, LIMITED, LONDON," IN CIRCULAR DEVICE.—Electrodes for welding. Welding Supplies, Limited, Anchor and Hope Lane, Charlton, London, S E.7.

XUM

Sterling

ROLLED STEEL
MOULDING BOXES
INCREASE OUTPUT
AND
CHEAPEN PRODUCTION

In the course of a day's work each box part must be handled several times. For quantity production, therefore, light moulding boxes are essential.

To withstand the brunt of rapid handling and the heavy pressures of the modern moulding machine, the box must be strong, rigid and unbreakable.

For the production of castings true to pattern free from fins and crossed joints, accurate moulding boxes are not only necessary but vital.

THE SOLUTION IS
THE STERLING ROLLED STEEL BOX

In no other type of moulding box will you find such uniform accuracy of pins and parting faces, nor just that correct ratio of the necessary factors to ensure long life without undue weight.

LET US HAVE YOUR ENQUIRY FOR YOUR NEXT LOT OF BOXES.

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone: 3345 BEDFORD.
Telegrams: "STERFLASK, BEDFORD."
Code: WESTERN UNION.

Glasgow: ALBERT SMITH & CO., 60, ST. ENOCH SQUARE, GLASGOW, C.1.
Newcastle-on-Tyne: PARSON & COLLS, CLARENDON HOUSE, CLAYTON STREET W., NEWCASTLE-ON-TYNE.
Manchester: F. L. HUNT & CO., CHAPEL STREET, SALFORD, MANCHESTER.

Raw Material Markets

Buyers of pig-iron still show a reluctance to enter into forward commitments, and although during the last week or so more contract business has been done, it does not represent the volume which was expected in view of the number of orders which have run out. Users apparently do not anticipate that the market will move against them. Conditions in the steel trade are steady, and in some departments show further improvement. Some good orders for railway material have been received from abroad. Tinplate prices have risen following the completion of an international agreement.

Pig-Iron

MIDDLESBROUGH.—The usual seasonal quietness is being seen in the Cleveland iron trade. The Falkirk holidays have finished, but, on the other hand, the Glasgow Fair holidays are now on. The ironmasters, however, regard the outlook as being favourable, and are not worrying about any small tonnages of iron that may be accumulating, believing that these will soon disappear with the recrudescence of demand which is expected before very long. Prices meanwhile are unaltered, fixed delivered prices for No. 3 Cleveland G.M.B. being:—Middlesbrough area, 67s. 6d.; North-East Coast, 69s. 6d.; Falkirk, 67s. 3d.; Glasgow, 70s. 3d. No. 1 foundry iron is 2s. 6d. more and No. 4 foundry and No. 4 forge iron are 1s. per ton less than No. 3 G.M.B.

The East Coast hematite makers are still busy. They have orders in hand, and deliveries against these are being taken as contracted. Steelmakers, of course, take large tonnages, but the quantity going for foundry and other use is well maintained. Mixed numbers are quoted at 67s. 6d. to users in the Middlesbrough area, rates for other parts of the country varying according to delivery.

LANCASHIRE.—Consumption is maintained on a good scale, and, if anything, the tendency would seem to be towards further improvement, although holidays in various parts are slowing down deliveries in some cases. The light-castings makers continue to be well engaged. Consumers generally still show a disposition to delay forward booking for as long as possible. Quotations are unchanged from last week. Derbyshire, Staffordshire and Cleveland brands of No. 3 iron are quoted for delivery to users in the Lancashire zone at 74s. per ton, with Northants at 72s. 6d. and Derbyshire forge iron at a minimum of 69s. There is a fair trade in East Coast hematite at from 75s. to 76s. per ton, according to grade. West Coast hematite is quoted at about 80s. 6d., with Scottish pig-iron at around 82s. 6d., all delivered equal to Manchester.

MIDLANDS.—Contracts have been renewed in a number of cases up to the end of the year, but there is still evidence of a reluctance among ironfounders generally to renew contracts, although any question of lower prices would appear to be very unlikely. The present minimum controlled prices are 67s. 6d. per ton for Northants No. 3, and 71s. for Derbyshire, Lincolnshire and Staffordshire No. 3, delivered to Birmingham and Black Country stations or sidings, and subject to a small graduated rebate for large tonnages. The light foundries continue to be well engaged, and rather increased tonnages are going into consumption in the engineering trade.

SCOTLAND.—The Falkirk foundries have restarted and have a good volume of work in hand. The Glasgow Fair holidays, however, are now on, and this fact has quietened down business considerably. The outlook is regarded favourably. There is no change in prices. No. 3 Scottish foundry iron is 70s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. The official prices for No. 3 Cleveland are maintained at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow.

Coke

The foundry-coke market is strong, and looks like remaining so. Most users have booked ahead as much as possible. Present anticipations are that any movement of prices will be towards a higher level. Current quotations for delivery in the Birmingham area are:—Best Durham coke, 36s. to 40s., according to quality; Welsh coke, 37s. 6d. to 45s. per ton.

Steel

In semi-finished steel business has improved slightly, but the demand is still below the level experienced a few weeks ago. Continental steel has been quoted, duty included, at low prices, but comparatively little business has been placed abroad. Demand for finished steel has been irregular, but works have sufficient orders in hand to keep them busy for some time. Lately inquiry from overseas markets has become more active.

Scrap

Cast-iron scrap prices are maintained, but the demand is irregular, being consistently steady in some areas and showing a quiet trend in others. In the Middlesbrough area ordinary heavy metal is still priced at 50s. and machinery quality at 53s. 6d., with only a quiet demand. In South Wales, too, the market is somewhat slow, prices in this area being around 42s. 6d. for light metal, 47s. 6d. for heavy cast iron, and 50s. to 52s. 6d. for machinery scrap. The demand shows a decline in the Sheffield area and 45s. seems to be the best price obtainable for light castings, with 50s. for ordinary and 52s. 6d. for machinery quality. In the Midlands, owing to the steadiness of the foundry trade, there is a consistent demand for scrap, at firm prices. For heavy machinery metal in handy sizes the merchants are asking 55s.; good heavy pipe and plate is at 50s. and clean light at 47s. 6d. Holidays have curtailed the demand in Scotland, and heavy machinery cast-iron scrap is difficult to dispose of at 55s., with heavy ordinary cast iron suitable for foundries at 51s. 3d. to 52s. 6d. Old cast-iron railway chairs are still firm, on account of the scarcity, at 57s. 6d. to 58s., with light cast-iron scrap at 45s. and firebars 37s. 6d. The above prices are all per ton, delivered works.

Metals

Copper.—The weak tone in this market continues, and must still be attributed to the unsettled conditions in Germany and the restrictions prevailing in that country; not only in regard to payments, but also in respect of the importation of raw material, which it is feared must have an adverse influence on the consumption of copper; and the metal which would normally be sold to that country might be diverted to the standard market in London. Selling pressure here has at times been heavy, state Messrs. Rudolf Wolff & Company, and the easier tendency has occasioned a fair volume of liquidation by tired holders, but latterly the pressure has been relaxed, the lower prices having attracted some buying, and values have in a measure recovered.

Daily quotations:—

Cash.—Thursday, £29 18s. 9d. to £30; Friday, £30 to £30 1s. 3d.; Monday, £29 8s. 9d. to £29 10s.; Tuesday, £29 3s. 9d. to £29 5s.; Wednesday, £29 10s. to £29 12s. 6d.

Three Months.—Thursday, £30 6s. 3d. to £30 7s. 6d.; Friday, £30 6s. 3d. to £30 7s. 6d.; Monday, £29 16s. 3d. to £29 17s. 6d.; Tuesday, £29 11s. 3d. to £29 12s. 6d.; Wednesday, £29 17s. 6d. to £29 18s. 9d.

Tin.—Trading conditions show little change on the week. A fair amount of metal is being sold to consumers in this country, but quiet conditions rule on the Continent and in the United States of America. Influential support to the market is forthcoming whenever necessary, thus serving to uphold prices.

Market prices:—

Cash.—Thursday, £230 17s. 6d. to £231; Friday, £230 12s. 6d. to £230 15s.; Monday, £230 10s. to £230 12s. 6d.; Tuesday, £230 15s. to £231; Wednesday, £230 10s. to £230 12s. 6d.

Three Months.—Thursday, £230 to £230 5s.; Friday, £230 to £230 2s. 6d.; Monday, £230 to £230 2s. 6d.; Tuesday, £230 5s. to £230 7s. 6d.; Wednesday, £230 5s. to £230 7s. 6d.

Spelter.—Trade demand is only moderate, the easier tendency influencing consumers to provide only their immediate requirements, and business on the Continent has also been quiet. In the United States the market has displayed a slightly hardening tendency.

Messrs. Rudolf Wolff & Company state: "The market continues to be very largely under the influence of the unsettled conditions obtaining in Germany, and the possibility that the restrictions placed on imports, together with the efforts which Germany is making to be self-supporting in regard to raw material, may have a disturbing effect on Cartel arrangements. Buyers, pending more definite indications as to developments, have in consequence displayed some reserve."

Day-by-day prices:—

Ordinary.—Thursday, £13 7s. 6d.; Friday, £13 6s. 3d.; Monday, £13 3s. 9d.; Tuesday, £13 1s. 3d.; Wednesday, £13 7s. 6d.

Lead.—This market has been steady. A moderate business has taken place day by day. Offerings have, on the whole, been light, and the market has been well supported, steady conditions in consequence prevailing. Consumers' demand is fairly well maintained in this country, and, apart from the Continent, where business has continued slow, the general position would seem to be fairly satisfactory.

Market fluctuations:—

Soft Foreign (Prompt).—Thursday, £10 16s. 3d.; Friday, £10 15s.; Monday, £10 17s. 6d.; Tuesday, £10 13s. 9d.; Wednesday, £10 18s. 9d.

G. A. Harvey & Company (London), Limited

DIAMOND JUBILEE CELEBRATION

Messrs. G. A. Harvey & Company (London), Limited, celebrated their diamond jubilee recently. In the past 60 years the company has developed from a one-man concern to a firm employing about 2,000 people. The present chairman, Mr. G. A. Harvey, who founded the firm, has now relinquished direct control to his son, Mr. Sydney Harvey. Sixty years ago Mr. G. A. Harvey started in business for himself by acquiring an old forge in Lewisham. This he converted into a workshop, and, with the assistance of one boy, carried on the business of a zinc worker, to which trade he had been apprenticed. This nucleus of a works occupied less than half an acre of ground, and the production consisted mainly of materials in zinc—cistern linings, guttering, etc.—for the requirements of local builders. To-day the works extend over 28 acres, and are devoted to many-sided industrial activities. In addition to the factory at Lewisham, galvanising and tank-making works were established at Iron Wharf, Greenwich, in 1894, but even these two establishments were insufficient as the business grew and export trade was catered for, and in 1913 the works in Woolwich Road, Greenwich, were acquired.

It is here that the present activities of the firm are now concentrated, though there have had to be several additions to cope with the initiation of new developments; and even to-day the business is progressing at such a rate that work on new buildings has been started. The products manufactured include fine wire cloth in copper, bronze or brass, metal perforated work, steel furniture and garage equipment. They also include heavy industrial plant of a specialised character, such as pressure vessels, distillation and impregnating plants, fractionating towers, reaction vessels, solvent recovery plants, etc. There are special departments for engineering, galvanising, metal perforating, galvanised goods, tank work, steel-plate working, welding, wire working and woven wire; and the machinery and general equipment of the factory is of the most modern description.

Messrs. Harvey do their own press work and possess a large range of standard dies for the production of dished and flanged ends of all sizes.

Welfare work is enthusiastically pursued. The firm possesses a well-equipped institute and a spacious sports ground, and the keenest interest is taken by the management in the various recreational activities of their employees, as well as in their general health and well-being. It is interesting to note also that once a month a conference is held between the directors and a works council to deal with matters calling for mutual discussion.

Influence of Graphite on the Properties of Cast Iron

(*Concluded from page* 42.)

had the quality only of the small networks where it was hypo-eutectic.

He had not been able to carry out experimental work as to stresses in the small samples dealt with, which weighed only a few hundred grammes, and which were made in a small carbon crucible. They were not made purposely for the investigation of strength and hardness or stresses, but for determination of gases, such as hydrogen, nitrogen and oxygen. Incidentally, he had cut them open and polished them in order to see the internal structure.

XUM

BRITISH ROLL FOUNDRIES

Part of Rollturning Shop of the Glanmor Foundry Co., Ltd., Llanelly, showing Rolls, all of which contain

DUD·L.N.F'ces·DUD THE GENUINE COLD BLAST PIG IRONS: GRAZEBROOK LOWMOOR C.B.

GENUINE COLD BLAST PIG IRON

The Chilling quality of Genuine Cold Blast Pig Iron is inherent and gives to the chilled castings a grey background which entails resiliency and capacity to withstand strain due to Fatigue, Torsion, Heat and Shock.

Brand :	"DUD·L.N.F'ces·DUD"	THE EARL OF DUDLEY'S ROUND OAK WORKS, LTD., BRIERLEY HILL, STAFFS
Brand :	"GRAZEBROOK"	M. & W. GRAZEBROOK, LTD., DUDLEY, WORCESTERSHIRE.
Brand :	"LOWMOOR C.B."	THE LOW MOOR IRON CO., LTD., NEW WORKS, LOW MOOR, BRADFORD.

XUM

RAW MATERIALS—PRICE LIST

(Wednesday, July 18, 1934)

COPPER

	£	s.	d.
Standard cash	29	10	0
Three months	29	17	6
Electrolytic	32	10	0
Tough	31	10	0
Best selected	32	0	0
Sheets	60	0	0
India	42	10	0
Wire bars	33	0	0
Ingot bars	33	0	0
H.C. wire rods	35	5	0
Off. av. cash, June	32	3	9
Do., 3 mths., June	32	10	5 5/16
Do., Sttlmnt., June	32	3	9 5/16
Do., Electro, June	35	10	7 1/2
Do., B.S., June	35	3	7 1/2
Do., wire bars, June	35	14	4 9/16
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7⅝d.
Wire	7⅜d.
Rolled metal	6⅝d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	230	10	0
Three months	230	5	0
English	230	12	6
Bars	232	12	6
Straits	230	17	6
Australian (nom.)	—		
Eastern	230	0	0
Banca	231	10	0
Off. av. cash, June	226	19	9 6/7
Do., 3 mths., June	226	3	6 1/7
Do., Sttlmt., June	226	18	9 2/7

SPELTER

	£	s.	d.
Ordinary	13	7	6
Remelted	14	0	0
Hard	11	0	0
Electro 99.9	16	0	0
English	14	0	0
India	13	0	0
Zinc dust	16	5	0
Zinc ashes	3	0	0
Off. aver., June	14	7	1
Aver. spot, June	14	4	9 2/7

LEAD

	£	s.	d.
Soft foreign ppt.	10	18	9
Empire (nom.)	11	3	9
English	12	10	0
Off. average, June	11	3	0 11/14
Average spot, June	11	1	0 2/7

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	5	0
Do., V.M. ex whse.	21	12	6
Rods	27	10	0

ANTIMONY

	£	s.	d.	£	s.	d.
English	40	0	0 to	43	0	0
Chinese, ex-whse.				35	15	0
Crude				24	10	0

QUICKSILVER

	£	s.	d.	£	s.	d.
Quicksilver	11	0	0 to	11	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	13 0 0
75%	18 7 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	5/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	3/3 lb.
Tungsten metal powder—	
98/99%	3/6 lb.
Ferro-chrome—	
2/4% car.	29 15 0
1/6% car.	23 0 0
6/8% car.	21 12 6
8/10% car.	21 12 6
Ferro-chrome—	
Max. 2% car.	36 0 0
Max. 1% car.	38 15 0
Max. 0.70% car.	42 0 0
70%, carbon-free	10d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	14	0 to	2	15	0
Bundled shrngs.				2	7	6
Mixed iron and steel				2	10	0
Heavy cast iron				2	7	6
Good machinery	2	10	0 to	2	12	6
Cleveland—						
Heavy steel				2	10	0
Steel turnings				1	17	6
Cast-iron borings				1	7	6
Heavy forge				2	10	0
W.I. piling scrap				2	5	0
Cast-iron scrap	2	10	0 to	2	13	6
Midlands—						
Light cast-iron scrap				2	7	6
Heavy wrought iron				3	0	0
Steel turnings, f.o.r.				1	13	0
Scotland—						
Heavy steel	2	10	0 to	2	11	3
Ordinary cast iron	2	11	3 to	2	12	6
Engineers' turnings				2	0	0
Cast-iron borings				2	0	0
Wrought-iron piling	2	10	0 to	2	11	3
Heavy machinery				2	15	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	25	0	0
Brass	17	10	0
Lead (less usual draft)	9	10	0
Tea lead	7	0	0
Zinc	9	0	0
New aluminium cuttings	69	0	0
Braziery copper	22	0	0
Gunmetal	23	0	0
Hollow pewter	145	0	0
Shaped black pewter	110	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	68/-
Hematite M/Nos.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	80/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	12	6 to	9	15	0
Nut and bolt iron	7	10	0 to	8	0	0
Hoops	10	10	0 and up.			
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 and up.			
Bolts and nuts, ¾ in. × 4 in.				14	0	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	2	6 to	8	10	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)				8	12	0
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates	12	5	0 to	12	10	0
Hoops (Staffs)				9	7	0
Black sheets, 24g. (4-t. lots)				10	10	0
Galv. cor. shts. (,,)				13	0	0
Galv. flat shts. (,,)				12	10	0
Galv. fencing wire, 8g. plain				14	10	0
Billets, soft				5	10	0
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	5	0
Tin bars				5	0	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	11⅝d.
Rods	10¾d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.25
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.90
Steel bars	1.90
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.25
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/-
,, furnace	20/-
Durham foundry	21/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/-
,,	28×20 ,,		36/-
,,	20×10 ,,		—
,,	18¾×14 ,,		—
C.W.	20×14 ,,		—
,,	28×20 ,,		—
,,	20×10 ,,		—
,,	18⅝×14 ,,		—

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.	
July	12 ..	29	18	9	inc. 5/–
,,	13 ..	30	0	0	,, 1/3
,,	16 ..	29	8	9	dec. 11/3
,,	17 ..	29	3	9	,, 5/–
,,	18 ..	29	10	0	inc. 6/3

Electrolytic Copper

		£	s.	d.	
July	12 ..	33	0	0	inc. 5/–
,,	13 ..	33	0	0	No change
,,	16 ..	32	10	0	dec. 10/–
,,	17 ..	32	0	0	,, 10/–
,,	18 ..	32	10	0	inc. 10/–

Standard Tin (cash)

		£	s.	d.	
July	12 ..	230	17	6	inc. 2/6
,,	13 ..	230	12	6	dec. 5/–
,,	16 ..	230	10	0	,, 2/6
,,	17 ..	230	15	0	inc. 5/–
,,	18 ..	230	10	0	dec. 5/–

Tin (English ingots)

		£	s.	d.	
July	12 ..	231	2	6	No change
,,	13 ..	230	17	6	dec. 5/–
,,	16 ..	230	12	6	,, 5/–
,,	17 ..	231	2	6	inc. 10/–
,,	18 ..	230	12	6	dec. 10/–

Spelter (ordinary)

		£	s.	d.	
July	12 ..	13	7	6	dec. 1/3
,,	13 ..	13	6	3	,, 1/3
,,	16 ..	13	3	9	,, 2/6
,,	17 ..	13	1	3	,, 2/6
,,	18 ..	13	7	6	inc. 6/3

Spelter (Electro, 99.9 per cent.)

		£	s.	d.	
July	12 ..	16	1	3	inc. 1/3
,,	13 ..	16	0	0	dec. 1/3
,,	16 ..	15	17	6	,, 2/6
,,	17 ..	15	13	9	,, 3/9
,,	18 ..	16	0	0	inc. 6/3

Zinc Sheets (English)

		£	s.	d.	
July	12 ..	23	5	0	No change
,,	13 ..	23	5	0	,, ,,
,,	16 ..	23	5	0	,, ,,
,,	17 ..	23	5	0	,, ,,
,,	18 ..	23	5	0	,, ,,

Lead (English)

		£	s.	d.	
July	12 ..	12	10	0	No change
,,	13 ..	12	10	0	,, ,,
,,	16 ..	12	10	0	,, ,,
,,	17 ..	12	10	0	,, ,,
,,	18 ..	12	10	0	,, ,,

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in June and the six months, 1934, compared with a year ago.

	June.		Six months.		June.		Six months.	
	1933.	1934.	1933.	1934.	1933.	1934.	1933.	1934.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron, forge	—	—	—	—	—	—	—	—
,, foundry	2,034	486	17,945	14,971	7,588	1,403	60,728	42,672
,, acid	—	—	37	—	—	—	226	—
,, basic	4,618	1,000	23,749	34,167	12,460	3,038	63,530	92,253
Total (including other kinds)	6,652	2,781	41,731	56,055	20,048	11,763	124,484	175,557
Castings and forgings	103	422	607	1,990	1,890	10,850	13,559	50,020
Cast pipes and fittings	43	86	705	655	1,307	4,359	13,179	35,455
Stoves, grates, etc.	52	85	336	428	4,607	7,524	30,949	41,227
Baths	670	417	2,475	3,831	15,419	11,107	57,239	92,842
Hollow-ware, all kinds	254	267	1,032	1,284	9,588	13,742	44,131	70,417
Exports.								
Pig-iron, forge	151	127	1,030	589	609	535	4,040	2,410
,, foundry	3,890	5,739	20,911	34,634	12,149	21,295	73,454	119,013
,, acid	3,023	3,549	25,215	23,690	9,633	11,267	78,431	74,884
,, basic	70	—	880	778	247	—	3,453	2,523
Total	7,134	9,415	48,036	59,691	22,638	33,097	159,428	198,830
Castings and forgings	256	378	1,340	2,461	12,227	14,438	56,900	91,902
Cast pipes and fittings, up to 6 in. diameter	4,405	5,651	23,918	31,003	51,972	60,968	263,806	343,336
,, ,, ,, over 6 in. ,,	3,087	2,210	14,226	19,581	23,006	16,965	103,063	146,685
Stoves, grates, etc.	588	691	3,194	4,179	28,460	31,897	149,722	197,481
Sanitary cisterns	250	234	1,237	1,435	7,649	7,424	36,942	42,504
Bedsteads, inc. tubes therefor	306	456	1,984	2,641	10,317	14,950	74,094	86,964
Cast hollow-ware	398	324	2,008	1,692	15,645	11,773	81,287	64,600

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOUNDRY Manager required by Midland foundry (120 hands) producing motor and general engineers' castings, iron and aluminium. Must be extremely keen, fully efficient and capable of taking complete control. Only men with similar experience need apply. State capabilities, experience and salary required.—Apply, Box 814, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Foundry Foreman to take charge of general ironfoundry under superintendent. Must have had experience in loam and dry-sand castings up to 30 tons weight.—Apply, stating age, experience and salary required, to Box 812, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Manager for iron and brass foundry with varied output for machinery of marine type, steam and Diesel, mercantile and Admiralty; output about 1,500 tons per annum. Applicants should be under 40, with sufficient experience take complete charge all sides of the business.—Apply, Box 810, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Assistant Foreman Moulder for large foundries in India, not over 30 years, single. Conversant with machine-, dry-, green- and loam-moulding. Must have experience in moulding steel castings.—Apply by letter, enclosing copies of testimonials, to "MOULD," c/o W. ABBOTT, LIMITED, 32, Eastcheap, London, E.C.3.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Foreman desires position. Experienced in jobbing work, machine-moulding, estimating, cupola practice, etc. Will accept position as Working Foreman in small firm. (247)

MACHINERY

GENUINE Whittaker Gear-wheel Moulding Machine, all change wheels, perfect. Price £40. Inspection at Slough.

A. HAMMOND, 14, Australia Road, Slough.

Also Crane Ladles, all sizes, in stock.

SIX "Osborn" Jolt Squeezers, Type J75; good condition; will sell reasonably.—Box 816, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY—*Continued*

AIR COMPRESSORS.

ALL sizes of Air Compressors in stock at Slough. Also LADLES, all sizes up to 30 Tons.

A. HAMMOND, 14, Australia Road, Slough.

FOR Sale.—Fletcher Type Cupola, 30 in. dia., by Geo. Green & Company; 24-in. Cupola by Constructional—Moulding Machines, Ladles, Moulding Boxes, Milling Machines, Blowing Fans by Sturtevant and Keith Blackman.—Write for complete list to Box 808, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

"KETIN" Sand-preparing Plant, capacity 3 tons per hour, direct motor-driven, 440 volts, 3 close, 40 cycles; Sifter, Mixer, Mill and Disintegrator; in first-class condition.—Apply, Box 804, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TILGHMAN'S SAND-BLAST PLANTS AND AIR COMPRESSORS

We always have in stock
SECONDHAND RE-CONDITIONED
PLANTS and New Sand-blast Plants,
Also
RE-CONDITIONED AIR COMPRESSORS
and New Compressors.
All Sizes—All Pressures.
We SHOT (or Sand) Blast for all Trades.

R. J. RICHARDSON & SONS, LTD.,
COMMERCIAL STREET, BIRMINGHAM, 1.

THOS. W. WARD LTD.

Hori. ENGINE, 9" dia. cyl.; 12" str.; 7' 0" dia. flywheel.

464 cub. ft. AIR COMPRESSOR, 12" dia. cyl; 14" str.; belt-dr.; 100 lbs. press.

11" cen. S.S. and Sc. LATHES, admit 60"; 15" swing over saddle.

30-n.h.p. Semi-Port. LOCO. BOILER, new in 1923; 120 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

SANDBLAST PLANTS

Room, Rotary Barrel and Cabinet Types complete; 12 in stock.

SAND PLANT

Sand Mills, 6-ft., 5-ft. and 4-ft. 6-in. dia. Pans.

Rotoil "Senior" Oil Core Sand Mixer.

Pneulec Sand Drying Plant, output 1 ton per hour.

Brearley Type Disintegrators.

MOULDING MACHINES

Hand and Pneumatic Types.

Also

Six Rowlands Double-ended Grinders for 24-in. dia. x 2-in. wheels.

Electrical and Belt-driven Blowers and Exhaust Fans, Ladles, etc., etc.

AIR COMPRESSORS

All sizes for high and low pressures.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

FOR SALE BY PRIVATE TREATY

By Direction of TRIPLEX FOUNDRY, LIMITED, GREAT BRIDGE, STAFFS, who are shortly removing to their New Foundry at Tipton.

FOR SALE BY PRIVATE TREATY,
WITH POSSESSION ON COMPLETION,
The Substantially-built and Extensive
FREEHOLD MANUFACTURING PREMISES,
Situate at Bridge Road and Toll End Road,
GREAT BRIDGE, TIPTON, STAFFS,
COMPRISING A TOTAL AREA OF 20,900 SQUARE YARDS
with RUNWAYS and FIRST-CLASS MELTING PLANT.

There is a frontage to Canal Basin of about 1,000 ft. The distance from the L.M. & S. and G.W.R. Goods Stations at Great Bridge is ¼-mile, and services include South Staffs and Canal Water Supplies, Gas and Electric Light and Power.

First-class South Staffordshire labour is available in the district.

Further particulars and Permits to Inspect may be obtained from J. V. BOSWELL & COMPANY, F.A.I., Auctioneers and Valuers, 4, Waterloo Road, Wolverhampton (Telephone 21216/7), or MESSRS. CHESSHIRE, GIBSON & COMPANY, F.A.I., Auctioneers and Valuers, 21, Waterloo Street, Birmingham (Telephone Midland 6651/2).

MISCELLANEOUS

FLUIDITY TESTS as described in THE FOUNDRY TRADE JOURNAL, February 1, 1934. Patterns of the above in aluminium can be supplied for 35s. per set. Post free. We can also supply Patterns for all branches of the engineering trade, in hard or soft woods. Send us your inquiries.—FURMSTON & LAWLOR, Patternmakers, Letchworth, Herts.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1934 edition. Price 42s. cloth bound, 52s. morocco. Order *YOUR* copy *NOW*.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

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12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories **£290 Nett.**

T.B. 1 Tilghman sandblast barrel plant, complete. CHEAP.

T.B. 3 Tilghman sandblast barrel plant, double-jet, complete. CHEAP.

6' "Jackman" rotary sandblast table. CHEAP seen working.

SAND PLANT

Herbert "Whizzer" type disintegrator, No. 1 **£30**
Pneumatic riddle, by Macdonald **£8**
Large "Baillott" sand preparing plant CHEAP.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
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